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COUNTRY MILK-RECEIVING AND COOLING STATIONS

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INTRODUCTION

Much of the market milk for large cities is not shipped direct from the farm to the city pasteurizing plant, but is handled through country receiving and cooling stations which provide facilities for assembling milk from various producers, weighing, and cooling it before shipment to the city. Milk-receiving stations in some localities are owned and operated by the producers through their cooperative organizations. However, a considerable proportion of country plants is owned by city milk dealers.

Information on the construction, arrangement, and operation of country receiving and cooling stations, and their relative advantages and economies as compared with direct shipment, is presented in this circular. Data are also presented on volume of milk required for economical plant operation, labor requirements, and methods of transportation. Plans devised by the Bureau of Dairy Industry are included for recommended types of construction for plants of various capacities. Although some country plants are equipped for manufacturing milk products from surplus milk, this circular discusses primarily the country receiving and cooling station where all the milk is shipped as market milk.

COMPARISON OF USE OF COUNTRY STATIONS WITH DIRECT SHIPMENT

Where milk is produced on farms near the city, and is shipped to the city in cans, direct shipment is usually more economical than it would be to have a country receiving and cooling station. Country receiving stations are usually located at distances ranging from less than 30 to more than 400 miles from the city. The use of country receiving stations to collect and prepare milk for shipment to the city plant, has several advantages: (1) Milk may be shipped greater distances and arrive at the city in better condition; (2) shipment in bulk to facilitate handling and reduce transportation costs is more practicable; and (3) the handling and delivery of milk from the farm to the shipping point is simplified.

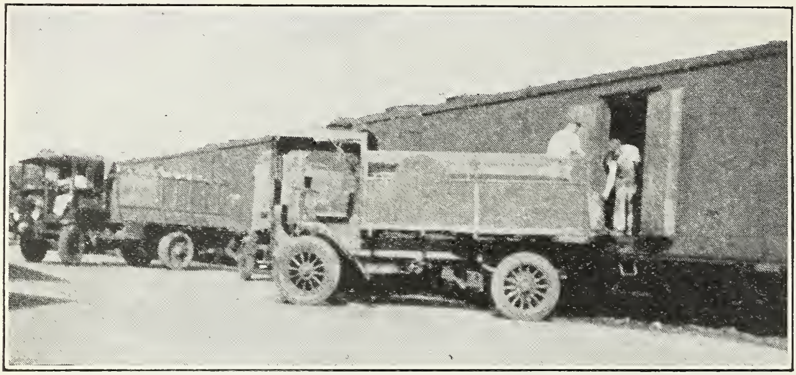

FIGURE 1.—Transferring milk to trucks from railroad cars on arrival at city terminal yards.

Direct shipments of milk to the city in cans are now possible for greater distances than formerly, because of good, hard-surfaced roads and because more producers have learned how to cool and care for milk properly on the farm. Under such conditions, the extra expense of establishing and maintaining a country cooling station is not warranted in many cases. However, market milk is produced in many localities at distances from the city too great for economical transportation by truck, and in such localities country cooling stations may be necessary even if the milk is shipped in cans.

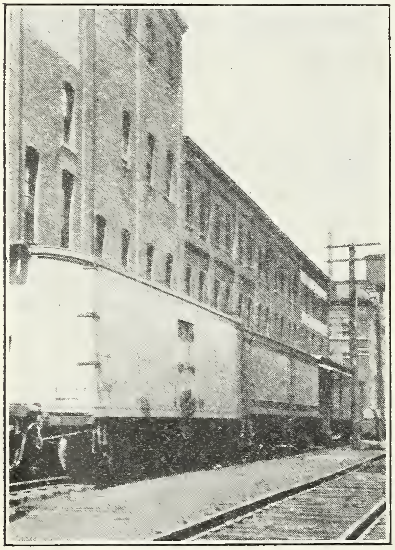

FIGURE 2.—Carloads of milk from country receiving stations "spotted" at city milk plant.

With the increasing use of tank trucks and tank cars for transportation of milk there is an increasing necessity for country receiving stations. Where milk is transported in tanks country receiving stations are indispensable because the milk must be assembled and cooled before shipment, even though the distance to the city may not be great.

The development of dairying in a community is facilitated by the presence of a receiving station because it provides a regular, local market. Closer contact is maintained between the producers and the distributor, a more stable market is provided locally for the producers, and more regular patrons for the distributor.

Where a full carload of milk is shipped from one country plant, or in some cases from two country plants, advantage can be taken of the carload freight rate.

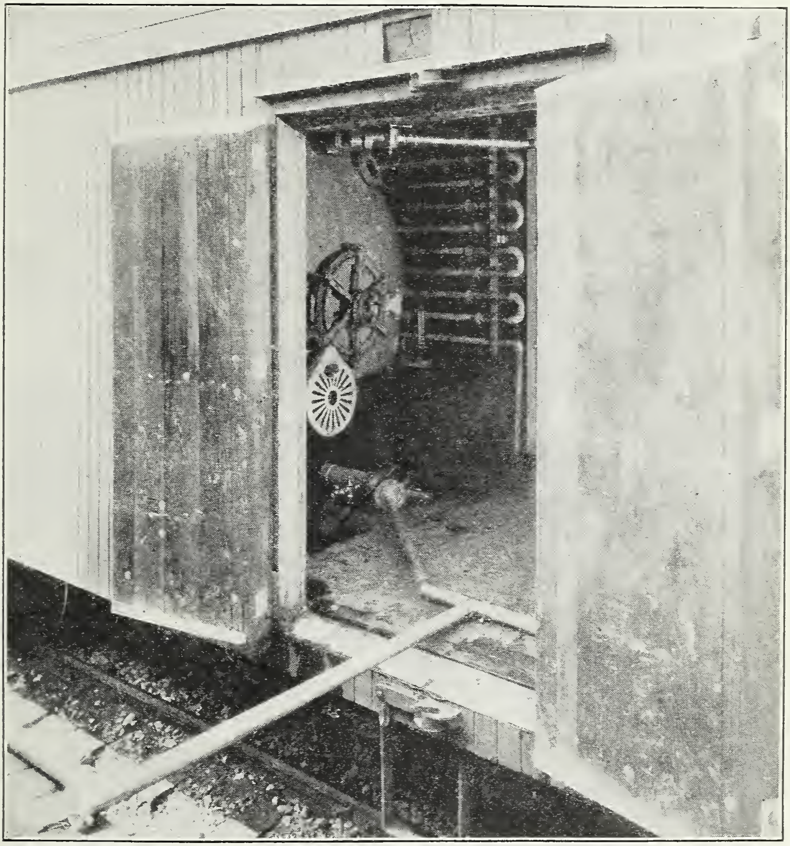

FIGURE 3.—Milk being drawn from tank car into city plant on arrival of car from country receiving station.

Shipping the milk by truck from country receiving stations eliminates rehandling (fig. 1) at the railroad terminal in the city unless the city plant is on a siding (figs. 2 and 3). Shipping the milk by tank truck or tank car from country plants eliminates the use of cans and reduces freight costs. Furthermore, the system of shipping by tank trucks enables the distributor to time the arrival of the milk at the city plant to meet operating conditions there.

At country receiving stations a closer check can be kept on the quality of the milk received from each producer than is usually convenient at city plants, except one processing milk produced on nearby farms. The operator of the country receiving station can be very helpful in instructing a producer who offers low-quality milk regarding the production and care of his product so that it arrives at the station in the best possible condition. He can also often assist the producers in problems of economical milk production. Other advantages of a country plant are that the producer has no train schedules to meet; he need not cool the morning's milk, provided it reaches the plant shortly after milking; and he may see his milk weighed and sampled. Then, too, there is less likelihood of producers' cans getting lost.

By establishing country receiving stations the surplus milk can be held in the country and manufactured into milk products, thus saving transportation costs. Usually where there are several country plants under the same management one or more of them is equipped for manufacturing milk products, and when there is a surplus the market-milk shipments are cut off from these plants.

CHOOSING THE LOCATION OF A COUNTRY RECEIVING STATION

Some of the factors that should be considered in choosing a location for a milk-receiving and cooling station are (1) nearness to a sufficient number of dairy cows to insure an adequate volume of milk, (2) prospective competition for the milk supply, (3) ample supply of good water and facilities for sewage disposal, (4) proper shipping facilities, and (5) availability of electric power.

NEARNESS TO A SUFFICIENT NUMBER OF DAIRY COWS

In choosing the location of a country receiving station, it is usually advisable to locate it in a good dairy section where enough cows are available to provide an adequate volume of milk. At least 10,000 pounds of milk are required daily to operate the plant economically, as shown under Operating Costs (pp. 14 to 22). Long hauls are undesirable in bringing milk from the farms of patrons to the country receiving station, because they add to the expense and may also result in milk arriving in poor condition. The permissible length of haul will depend on the type of roads and the quantity of milk available. Unless the roads are good, there should be a sufficient supply of milk within about 8 miles of the proposed station. Where there are good, hard-surfaced roads, considerably greater distances can be covered by autotruck, provided there is enough milk available to insure a paying load.

Data obtained on 176 stations showed that the maximum distance hauled ranged from 3 to 40 miles. The average maximum distance was 10.8 miles, and while there was a great variation in the distance of producers from each plant the most common average distance was from 5 to 8 miles.

Although it is generally advisable to build a receiving station only in a well-developed dairy section to insure a plentiful supply of milk near at hand, it may be desirable to establish a plant in a locality where the industry can be developed, although the existing production is not enough to operate a plant satisfactorily. In many cases the production of milk can be stimulated by the establishment of a country receiving station.

COMPETITION FOR MILK SUPPLY

Competition for the milk supply is an important item to be considered in the location of the plant. If the plant is located near that of a competing company, not only may difficulties arise between the two companies, but the volume of milk that can be obtained will probably be too small for the most economical plant operation. Competition from other city markets should also be considered and the plant should preferably not be located near the territory that would normally be drawn upon by other cities. Not only would this cause a division of the supply between the two markets so that the volume per plant would be low, but there might be a difference in the prices paid by the two markets, which at certain times might result in the loss of many patrons who would naturally seek the higher priced market.

In some sections of the United States stations have been established in large numbers quite close to each other. The original cause was usually that several competing companies established stations in the same producing area. Later, several of these stations might fall into the hands of one organization and be consolidated into one plant because of the excessive costs per ynit for separate operation and the economies in plant operation that could be effected by combining into one plant.

It is not desirable to locate the plant too near the city, for as the city grows the milk-producing area will gradually be pushed away by other industries and interests. Furthermore, with the increase of good roads, stations located too near the city are subject to the competition of direct haulers from the producers to the city plants. This competition may be an especially important factor during the season of milk shortage.

All factors considered, it is desirable to locate the station in an area that is either a good dairy section or that can be developed into one, and that, if possible, is far enough from city plants and from other country plants to render outside competition an unimportant factor. The selection of a distant location for the station is often desirable because such areas have a chance to grow with the growth of the city and the increased demands for milk.

WATER SUPPLY

An ample supply of good water is essential for the successful operation of a milk-receiving and cooling station. The water used for cleaning cans, equipment, etc., must be pure and uncontaminated. It is also desirable that the water be as cold as possible so that much of the cooling of the milk may be accomplished with it. A survey of 201 milk-receiving stations showed that the systems used to procure water were as follows:

System used:	*Number of stations*
Own well (usually driven well)	156
City water	28
Own well and city water	8
Spring	4
Own well and spring	3
River and own well	2
	201

It will be noted that most of the plants had their own wells. City water is expensive, as a large quantity is necessary. It is therefore desirable for a milk-receiving station to have its own well and to have one deep enough to provide an ample supply of pure, cold water at all times. Some plants so situated that city water is available do not depend on this supply alone, but use well water either partly or entirely, and can use it in the event something happens to the city supply. Water from a stream if available may be used for cooling purposes and for the generation of steam, but it should not be used for washing cans and equipment because of the possibility of contamination.

SEWAGE DISPOSAL

The proper disposal of sewage is an important point to be considered in establishing a country receiving plant. Many plants are located where it is impossible to use a city sewer. Deposit of the sewage in a stream is not desirable unless there is a large body of water. Where there is a large body of water it may be used, provided no laws prohibit the emptying of sewage into it. Septic tanks or cesspools are usually used where neither a city sewer nor a flowing stream is available. Cesspools are not satisfactory in heavy, nonporous soil. If the soil is porous, as in the case of sandy soil, the cesspool may be satisfactory; but the septic tank usually proves better, especially if there is much casein or albumen in the sewage. The septic tank should be large enough to handle the maximum quantity of sewage, and the best results are obtained when the quantity of sewage is uniform from day to day.

The systems of sewage disposal used at 128 country receiving stations are shown in table 1.

TABLE 1.—*Relative number of plants using different systems of sewage disposal*

System used	Plants	Percentage of total
	Number	
Creek or river	36	28.1
City sewer	30	23.4
Septic tank	19	14.9
Cesspool	17	13.3
Cesspool to creek	14	10.9
Piped to ditch or field	12	9.4
Total	128	100.0

PROPER SHIPPING FACILITIES

If the milk is to be shipped by rail, the plant should be located on the railroad so that the milk may be transferred directly from it to the cars. Where the milk is to be shipped by truck the plant should be located close to a good road. Even where trucks are to be used to transport the milk, however, it is often a good plan to locate in the vicinity of a railroad if possible, in case anything should happen to the truck-transportation system. This factor may be of considerable importance in sections where serious snowstorms and blizzards are common and the roads sometimes impassable.

ELECTRIC POWER

As electric power is desirable for operating the refrigerating machinery and other equipment in the plant, the location selected should have it available. This is usually not difficult, however, as electricity is now available in most sections of the country.

QUANTITIES OF MILK HANDLED AT COUNTRY RECEIVING STATIONS

There is a great variation in the quantity of milk handled at various country receiving stations. The average daily receipts per plant at the plants studied, shipping to eight markets, are shown in table 2.

TABLE 2.—*Quantities of milk handled per day at country receiving stations, together with number of producers and receipts per producer*

Plants shipping to—	Plants	Total receipts	Receipts per plant	Total producers	Producers per plant	Receipts per producer	
	Number	*Pounds*	*Pounds*	*Number*	*Number*	*Pounds* [1]	*Pounds* [2]
Harrisburg, Pa	4	16, 550	4, 137. 5	194	48. 5	92. 27	85. 31
Detroit, Mich	57	638, 014	11, 193. 2	7, 036	123. 4	95. 27	90. 68
St. Louis, Mo	5	73, 000	14, 600. 0	1, 073	214. 6	76. 48	68. 04
Baltimore, Md	12	205, 310	17, 109. 2	1, 446	120. 5	142. 69	141. 98
New York, N. Y	46	916, 294	19, 919. 4	4, 739	103. 0	225. 61	193. 35
Philadelphia, Pa	26	580, 622	22, 331. 6	4, 191	161. 2	143. 29	138. 54
Boston, Mass	13	308, 031	23, 694. 7	1, 859	143. 0	174. 96	165. 69
Chicago, Ill	27	1, 231, 969	45, 628. 5	4, 503	166. 8	282. 69	273. 59
Total or average	190	3, 969, 790	20, 893. 6	25, 041	131. 8	167. 93	158. 53

[1] Average with plant as unit.

[2] Weighted average, with producer as unit.

The plants shipping to Harrisburg handled less milk than would usually be considered sufficient for economical plant operation. However, the investments in buildings and equipment at these plants were comparatively low, and the men operating them were engaged in this work only a few hours each day, thus reducing overhead and labor costs. The milk was shipped by truck in cans.

The quantities handled at the plants shipping to Detroit were also low; these plants all shipped by tank truck and many of them were each operated by one man, who in some cases spent only part of the day there. Many of these plants also had only a comparatively small investment in plant equipment, so that the overhead expense was comparatively low.

Separate results are not given for the individual plants in table 2. Although the average receipts per plant shown for the various groups shipping to other markets represent quantities sufficient for economical plant operation, a considerable number of plants, whose operations are not shown individually, handled too small a quantity for economical operation (pp. 14 to 22). Most of the plants shipping to New York and Boston and many of those shipping to Philadelphia and Chicago were located at a considerable distance from the market, while most of those shipping to Harrisburg, Detroit, St. Louis, and Baltimore were comparatively near.

The average number of producers per plant studied in the various localities and the average daily receipts per producer are also shown in table 2. The figures in the first of the columns under Receipts per producer are averages with the plant taken as a unit, and were obtained by dividing the sum of the average receipts per producer for each plant in the group by the number of plants in that group. For example, if five plants should average 60, 70, 80, 90, and 100 pounds per producer, respectively, the average for the group would be 80 pounds per producer. The figures in the last column show the weighted averages based on the total receipts for all plants in each group divided by the total number of producers in the group. It will be noted that the average receipts per producer were comparatively low at the plants shipping to Harrisburg, Detroit, and St. Louis, while they were much higher at the plants, located at considerable distances from the markets, shipping to New York, Boston, and Chicago.

SEASONAL VARIATION IN MILK RECEIPTS

Although buying plans designed to equate milk production throughout the year are in operation in most localities, there is still a considerable variation in milk receipts from month to month at country receiving stations. In table 3 the receipts for each month, expressed in terms of percentages, are compared with the 12-month average receipts for the year (taken as 100 percent) for each of 14 stations shipping to one distributor in the Middle West. The greatest range in milk receipts for different months for all stations was from 75.57 percent in November to 131.82 percent in June. At some individual stations the range was considerably greater than this; for example, at station no. 12 the receipts varied from 64.2 percent in November to 155.6 percent in June. Such wide variations in milk receipts naturally tend to increase the operating costs, as well as add to the seriousness of the surplus-disposal problem.

TABLE 3.—*Monthly milk receipts compared with the 12-month average receipts for the year at 14 country receiving stations shipping milk to one distributor*

Month	Percentage for station no.														Average
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
															Percent
January	103. 5	70. 8	92. 9	92. 1	94. 2	89. 9	88. 5	121. 0	92. 0	95. 2	111. 0	90. 1	95. 3	87. 9	93. 27
February	104. 7	73. 4	93. 8	89. 6	96. 0	87. 5	81. 7	108. 0	95. 8	93. 7	103. 9	79. 2	92. 0	88. 4	91. 64
March	114. 8	103. 7	102. 2	99. 5	108. 6	98. 9	92. 9	117. 9	104. 9	101. 2	103. 5	86. 7	98. 6	104. 9	103. 09
April	109. 8	102. 4	103. 0	101. 0	103. 9	101. 8	101. 9	115. 6	109. 6	103. 8	98. 6	107. 9	95. 1	112. 0	104. 31
May	120. 2	120. 2	123. 9	122. 7	124. 4	126. 4	124. 5	130. 1	121. 6	123. 8	114. 9	133. 7	115. 9	121. 0	120. 57
June	125. 6	131. 4	131. 9	126. 1	135. 5	141. 4	130. 9	130. 0	125. 8	131. 4	126. 2	155. 6	126. 3	125. 4	131. 82
July	107. 1	125. 5	112. 3	110. 3	109. 3	128. 6	123. 4	103. 2	118. 7	119. 3	110. 1	124. 2	110. 6	111. 0	118. 54
August	94. 3	114. 3	98. 3	98. 9	86. 7	112. 5	109. 1	82. 7	103. 3	103. 3	101. 6	116. 6	101. 0	96. 3	101. 54
September	88. 6	107. 4	89. 1	90. 1	81. 2	93. 1	94. 4	75. 9	93. 2	91. 7	93. 4	108. 3	100. 4	93. 3	92. 12
October	78. 8	91. 3	82. 8	90. 3	79. 2	80. 3	83. 3	66. 4	83. 1	76. 2	80. 2	65. 9	88. 2	87. 4	81. 96
November	69. 8	75. 3	82. 0	83. 3	79. 5	67. 3	80. 6	70. 1	72. 6	72. 2	73. 1	64. 2	83. 8	81. 8	75. 57
December	82. 8	84. 3	87. 8	96. 1	101. 5	72. 4	88. 8	79. 1	79. 4	88. 2	83. 5	67. 6	92. 8	90. 6	85. 57
Average	100. 0	100. 0	100. 0	100. 0	100. 0	100. 0	100. 0	100. 0	100. 0	100. 0	100. 0	100. 0	100. 0	100. 0	100. 00

TIME CONSUMED IN TRANSPORTING MILK FROM COUNTRY RECEIVING STATIONS TO VARIOUS CITY MARKETS

The average period of time the milk was in transit from the country receiving stations to the city for nine markets is shown in table 4. The systems of transportation from these stations to the city are also indicated.

TABLE 4.—*Time required to transport milk from 159 country stations to city, and methods of transportation used for nine markets*

Destination	Plants	Average quantity shipped daily per plant	Time milk is in transit from country plant to city [1]		Methods of transportation used [2]
			Average per plant	Range	
	Number	*Pounds*	*Hours*	*Hours*	
Harrisburg	4	4, 138	1. 25	1.00 to 2.00	Cans in trucks.
Kansas City	2	18, 500	1. 68	1.00 to 2.25	Tank trucks.
Baltimore	15	16, 645	2. 62	1.00 to 5.00	Do.
St. Louis	12	15, 666	2. 67	1.00 to 5.00	Tank trucks, and in cans by trucks.
Detroit	25	11, 840	3. 12	1.50 to 8.00	Tank trucks.
Chicago	25	45, 980	3. 52	1.50 to 7.00	Tank cars and tank trucks.
Philadelphia	23	24, 096	4. 43	1.00 to 9.50	Tank trucks, tank cars, and in cans by train.
New York	39	19, 026	12. 47	3.00 to 18.00	In cans by train, and by tank cars.
Boston	12	25, 208	16. 65	9.50 to 20.00	In cans by train.

[1] Where trucks were used, the time reported includes arrival at city plant; but where shipment was by train, the reported time usually includes only arrival at railroad platform in city.

[2] These data do not necessarily include all methods of transportation used in these markets, but only the methods used in shipping from the country stations studied.

The country plants studied which were shipping to Harrisburg, Pa., were located within a comparatively few miles of the city, and so were those shipping to Kansas City, Mo. As a rule less than 2 hours was spent driving from the country plants to the city plants.

The majority of the stations supplying Baltimore and of those serving St. Louis were also within a 2-hour run from the city by truck. However, a few stations were at considerable distances from the city, which brought the average time spent in transit to slightly over 2½ hours.

A considerable proportion of the stations shipping to Detroit were less than 50 miles distant from the city, but several were approximately 100 miles distant.

Much of the Chicago supply comes from the dairy sections of Wisconsin and is shipped to the city in tank cars. Some of the milk produced nearer the city is shipped by tank truck.

Many of the stations supplying Philadelphia with milk were located comparatively near the city, and the milk from these stations was shipped by tank truck. However, a considerable number of the stations were located in northern and central Pennsylvania, and shipments were made by tank cars and by train in cans.

From 39 stations studied which were shipping to New York City all shipments were made by train. Most of these stations were equipped to ship only in cans, but from some of the more recently established plants shipments were made in tank cars. Many of the stations were located in Pennsylvania and northern New York and were over 300 miles distant from New York City.

The 12 stations studied that were shipping to Boston were located in Vermont, principally in the northern portion, and as far away as 300 miles. Because a large number of New England cities consume much of the local supply much of the milk for Boston must come from a considerable distance. Many of the stations were located on branch lines of the railroad, so that the milk has to be shipped to a junction point, where it is picked up by the milk train on the main line. In addition to the milk received from country stations considerable milk is received in the Boston market by direct shipment from points still nearer. Most of the milk comes in by train, although a small proportion is received by truck, but all milk was shipped in cans by train from the stations studied.

RELATION OF VOLUME OF MILK HANDLED TO INVESTMENTS IN COUNTRY PLANTS

The investments in land, buildings, and equipment at 74 country plants of various sizes from which the milk was shipped to the city in cans are shown in table 5, and similar information for 54 plants from which the milk was shipped in tanks is given in table 6. The value of the land was figured on the original cost of the land, plus cost of improvements that have been made, less the amount of depreciation charged by the plant operators. The value of the buildings and value of equipment were calculated from the original cost, plus maintenance and repair costs, less depreciation.

Table 5.—*Relation of volume of milk handled to investments in land, buildings, and equipment at 74 country receiving stations from which the milk is shipped in cans*

Range of daily milk receipts (pounds)	Plants	Average quantity of milk received daily	Average investment in—					
			Land		Buildings		Equipment	
			Per plant	Per 100 pounds handled	Per plant	Per 100 pounds handled	Per plant	Per 100 pounds handled
	Number	*Pounds*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
5,000 or less	7	3,703	[1] 568.18	15.85	[2] 8,280.98	212.40	2,776.29	74.38
5,001–8,000	20	6,367	[3] 1,157.82	16.19	[4] 8,510.44	135.19	[3] 5,006.30	74.31
8,001–10,000	7	9,164	[2] 1,118.05	13.00	8,885.71	96.95	5,932.01	64.19
10,001–15,000	18	12,127	[5] 1,793.89	15.32	[5] 10,240.03	85.41	[6] 6,622.19	56.34
15,001–20,000	10	17,931	[7] 1,596.70	8.88	15,228.09	84.24	9,575.16	54.32
20,001–30,000	4	23,888	[8] 559.41	2.56	10,403.97	[9] 42.91	7,181.39	[9] 30.67
Over 30,000	8	38,456	2,509.98	6.22	22,093.98	58.14	[10] 21,369.91	54.72
All plants	74	13,732	1,622.45	12.91	[11] 11,619.13	102.83	[12] 6,966.90	61.96

[1] 4 plants.
[2] 5 plants.
[3] 15 plants.
[4] 18 plants.
[5] 17 plants.
[6] 16 plants.
[7] 7 plants.
[8] 2 plants.
[9] Most of the plants in this group consisted of old frame buildings and were poorly equipped.
[10] 6 plants.
[11] 69 plants.
[12] 65 plants.

Table 6.—*Relation of volume of milk handled to investments in land, buildings, and equipment at 54 country receiving stations from which the milk is shipped in tanks*

Range of daily milk receipts (pounds)	Plants	Average quantity of milk handled daily	Average investment in—					
			Land		Buildings		Equipment	
			Per plant	Per 100 pounds handled	Per plant	Per 100 pounds handled	Per plant	Per 100 pounds handled
	Number	*Pounds*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
5,001 to 8,000	4	6,163	[1] 867.26	13.16	[2] 3,926.18	64.73	4,799.82	74.72
8,001 to 10,000	7	8,601	693.98	8.22	2,827.72	[3] 33.76	4,340.87	[3] 51.31
10,001 to 15,000	7	12,924	[1] 900.00	6.65	[4] 8,814.12	69.01	7,731.78	61.23
15,001 to 20,000	10	17,250	[5] 699.58	3.68	[6] 7,481.95	41.84	[5] 9,188.67	52.34
20,001 to 30,000	9	25,047	1,176.04	4.75	[6] 9,205.90	37.63	12,892.93	51.93
30,001 to 50,000	11	43,690	2,566.19	5.83	21,869.79	[7] 49.07	22,217.32	49.34
Over 50,000	6	67,899	3,395.58	5.06	22,182.97	32.81	18,884.06	28.41
All plants	54	27,066	1,387.99	5.82	[8] 12,205.81	44.24	[9] 12,455.42	51.66

[1] 2 plants.
[2] 3 plants.
[3] Most of the plants in this group consisted of frame buildings and very simple equipment.
[4] 4 plants.
[5] 9 plants.
[6] 8 plants.
[7] Most plants in this group were of stone, reinforced concrete, or brick construction.
[8] 47 plants.
[9] 53 plants.

Many of the plants had been in use for a number of years, and the present net value of buildings and equipment, after adding the cost of repairs made and deducting the depreciation charges, is considerably less than would be the replacement cost. On the other hand, a considerable number of the plants were comparatively new, and very little had been charged off for depreciation.

The data in tables 5 and 6 show that as a rule both the investment in buildings and in equipment per 100 pounds of milk handled decreases as the size of the plant increases.

The investments in land do not bear any definite relation to size of plant and depend primarily on local conditions. Of the groups in table 5, with only one exception the investments in buildings and equipment per 100 pounds handled decreased as the volume of milk handled increased.

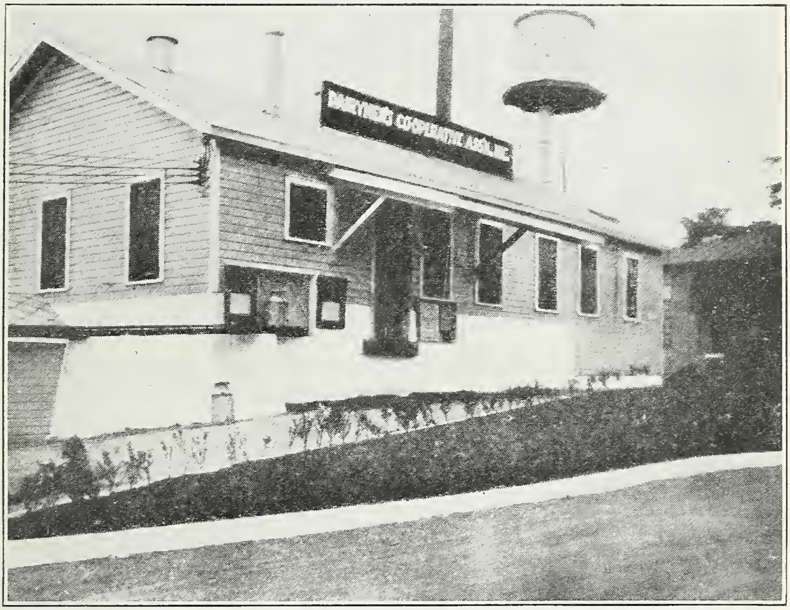

FIGURE 4.—A medium-sized country receiving station of frame construction, shipping in cans.

A typical plant of frame construction, shipping in cans, is shown in figure 4.

The group in table 6 handling between 8,000 and 10,000 pounds daily, consisted principally of small, inexpensive buildings (figs. 5 and 6) with simple equipment, many of them using water heaters and no steam boilers. The investments in this group were therefore comparatively low. Practically all the plants in the group handling between 30,000 and 50,000 pounds consisted of rather elaborate buildings of permanent construction, such as stone, brick (figs. 7 and 8), hollow tile or reinforced concrete, so that the investments in buildings were comparatively high.

The data in tables 5 and 6 not only show that the investment required per 100 pounds handled is as a rule greater at the plants with the smaller volume of milk, but also that a plant with a large volume is more economical per 100 pounds than a plant with a small volume. In many cases consolidation of two or three country receiving stations in one would result in a considerable decrease in the overhead costs, as well as in the direct costs of operation.

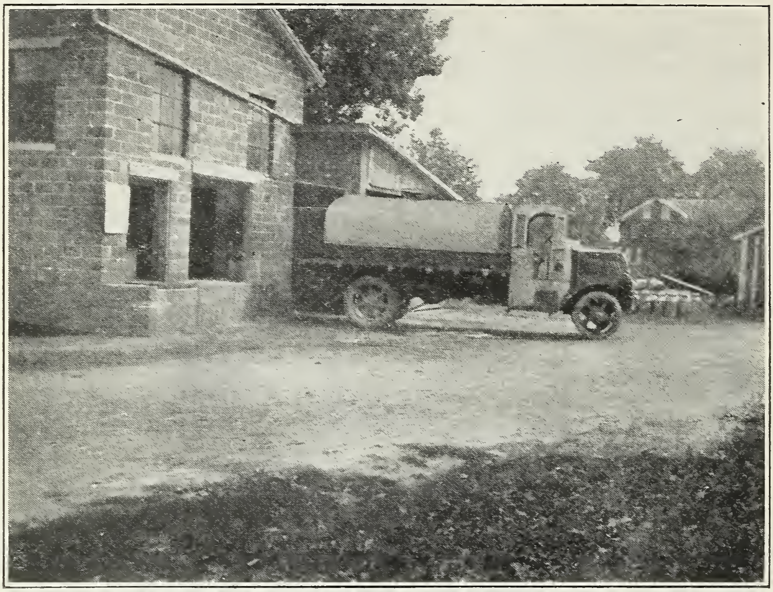

FIGURE 5.—A small country receiving station of hollow-tile construction, shipping in tank trucks.

The investments in buildings were uniformly larger for plants of similar capacities from which the milk was shipped in cans (table 5) than from which the milk was shipped in tank cars or tank trucks (table 6), principally because more floor space is required. Space must be provided for storing and washing the cans and also for filling them, whereas in the plants shipping in tanks the only corresponding

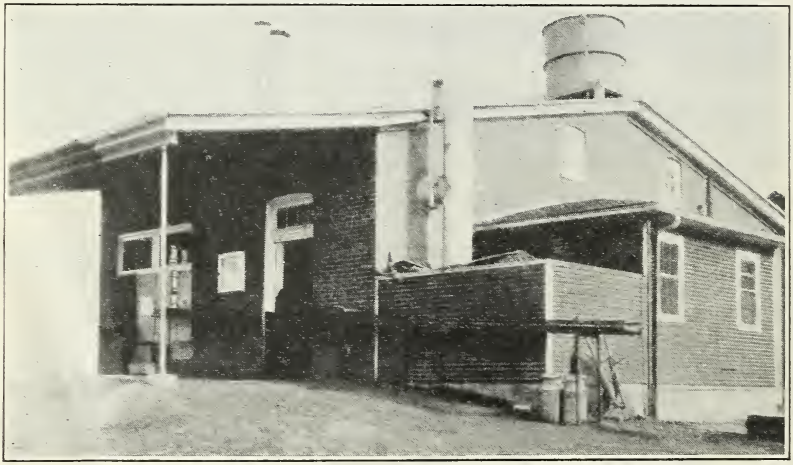

FIGURE 6.—A small country receiving station of brick and frame construction. Note conveyor for patrons' empty cans leading from receiving room door at left.

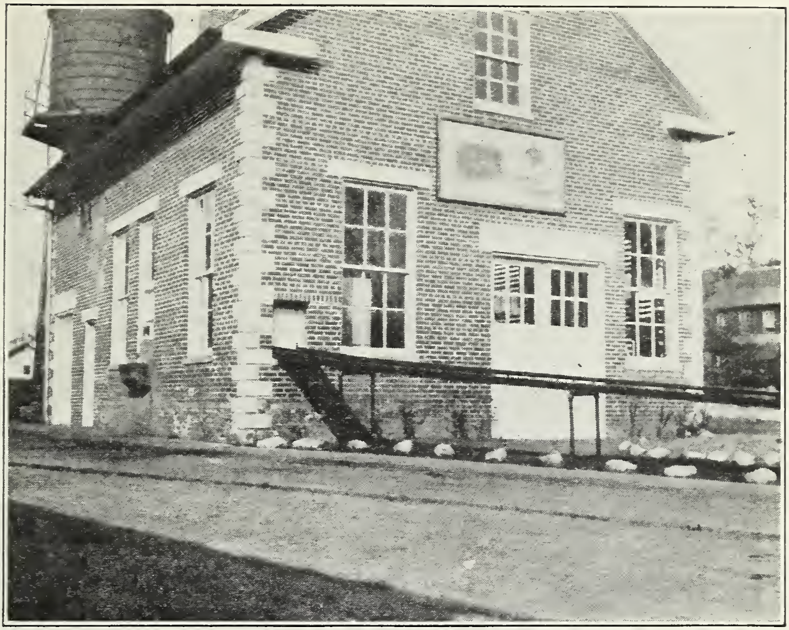

FIGURE 7.—A medium-sized, attractive country receiving station of brick construction. Note ample height of building to provide for an elevated milk-storage tank from which the milk flows by gravity to tank trucks. Long conveyor at right is for returning empty cans.

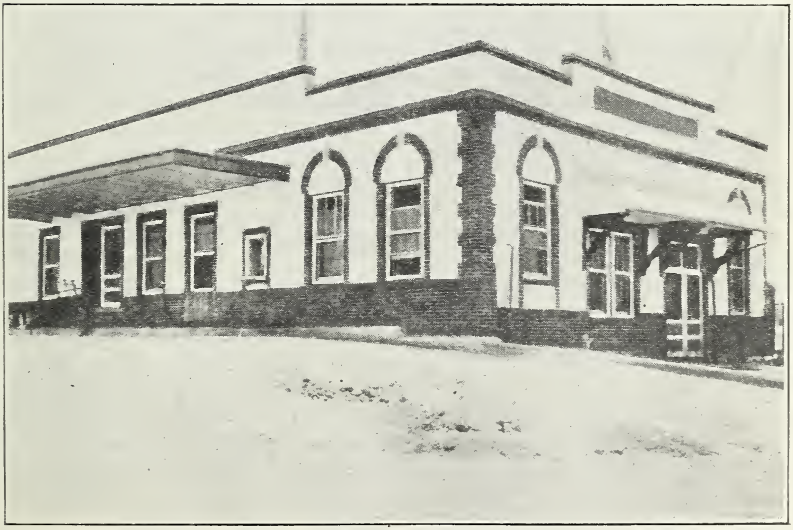

FIGURE 8.—A large modern country plant of glazed-brick construction. The milk is shipped in tank cars.

space required is for the milk-storage tanks. Another reason for the higher investments in buildings at plants shipping in cans is that some of them were not built for the purpose, and had considerable unused space.

The investments in equipment at the two types of plants were not much different for similar quantities handled, although they were as a rule slightly greater in the plants shipping in cans. These plants require an extra can washer, additional can conveyors, and a can filler, while those of the other type had no additional equipment except that most of them had milk-storage tanks in which to store the milk before the arrival of the tank cars or tank trucks.

OPERATING COSTS

RELATION OF VOLUME OF MILK HANDLED AND METHODS OF SHIPPING MILK TO OPERATING COSTS

The unit cost of operation of a country plant depends largely on the volume of milk handled. Numerous plants have been established where the available supply of milk is so small that operating cost per 100 pounds of milk received are very high. The establishment of such plants tends to increase the cost of marketing milk.

Information was obtained on the costs for labor alone at 125 and the total operating costs at 157 of the plants studied. From this was determined the cost per 100 pounds of milk received at these plants, grouped according to quantity received daily, and according to methods of shipping the milk to the city. The data on costs of operation were taken from the books of the organizations operating the plants. As a rule the records of operating costs did not include general overhead expenses, such as central office expenses for salaries of executives, accounting, sanitary control, etc. Since only a small number of plants had included these expenses in the books a deduction was made in such cases. At a few plants where these expenses were included and reported separately, they amounted to approximately 17 percent of the total costs of operation. Therefore, at a few other plants where these expenses were included but were not listed separately, a deduction of 17 percent was made.

The costs for labor alone and the total operating costs including labor per 100 pounds of milk handled at 47 plants from which the milk was shipped in cans are shown in table 7. It will be noted that the total operating cost per 100 pounds of the group of smallest plants was much greater than that of any other group, and was more than twice as great as that of the two groups of largest plants. Plants handling less than 5,000 pounds daily are few in number and expensive to operate. Such plants should be eliminated by transfering their patrons to other plants wherever possible or by increasing the volume handled. One reason for the relatively high operating cost at small plants is the high labor cost per 100 pounds. The percentage of the total cost that is charged to labor for different sizes of plants decreased slightly as the volume of milk handled increased. The labor cost in cents per 100 pounds, however, decreased considerably as the volume of milk received increased.

TABLE 7.—*Operating costs per 100 pounds of milk received at 47 receiving stations from which the milk was shipped in cans*

Range of daily milk receipts (pounds)	Plants	Milk received daily per plant	Total operating cost per 100 pounds	Cost for labor only	
				Per 100 pounds of milk	Percentage of total operating cost
	Number	*Pounds*	*Dollars*	*Dollars*	*Percent*
5,000 or less	4	3, 655	0. 4091	0. 2235	54. 7
5,001 to 10,000	19	7, 279	. 2466	. 1290	52. 5
10,001 to 20,000	20	13, 352	. 2106	. 1095	52. 3
20,001 to 30,000	2	21, 295	. 1747	. 0922	53. 5
Over 30,000	2	32, 895	. 2045	. 0931	45. 4
Total or average	47	11, 242	. 2403	. 1257	52. 3

The costs for labor alone at 50 plants and the total operating costs per 100 pounds of milk handled at 79 plants from which the milk was shipped in tank trucks are shown in table 8. As in the case of the plants shown in table 7, both the cost for labor and the total operating cost per 100 pounds tended to decrease as the volume of milk increased. The labor cost for those plants where such data were obtained was more than 50 percent of the total operating cost, except for the group handling between 15,000 and 20,000 pounds of milk daily. At the smaller plants labor was the principal item of expense. Many of these small plants consisted of inexpensive buildings with simple equipment, so that the overhead expense was comparatively low. Furthermore, many of these plants could have handled approximately twice as much milk with practically no additional labor. The cost figures in table 8 clearly illustrate the importance of volume of milk in lowering operating costs. All costs were lower at plants using tank trucks than at plants of similar size from which the milk was shipped in cans (table 7). At the latter type of plants much extra labor is required for washing the shipping cans, filling them, and loading them on the car or truck.

TABLE 8.—*Operating cost per 100 pounds of milk received at 79 receiving stations from which the milk was shipped in tank trucks*

Range of daily milk receipts (pounds)	Plants	Milk received daily per plant	Total operating cost per 100 pounds	Cost for labor only	
				Per 100 pounds of milk	Percentage of total operating cost
	Number	*Pounds*	*Dollars*	*Dollars*	*Percent*
Less than 5,000	5	3, 580	0. 1740	[1] 0. 1247	[1] 70. 0
5,001 to 10,000	30	7, 984	. 1291	[2] . 0650	[2] 59. 9
10,001 to 15,000	19	12, 510	. 0964	[3] . 0575	[3] 58. 2
15,001 to 20,000	14	17, 137	. 1070	[4] . 0532	[4] 46. 8
20,001 to 30,000	8	24, 313	. 0884	[5] . 0476	[5] 53. 8
Over 30,000	3	58, 144	. 1006	[6] . 0551	[6] 52. 3
Total or average	79	13, 976	. 1150	[7] . 0620	[7] 56. 5

[1] 3 plants. [2] 16 plants. [3] 14 plants. [4] 10 plants. [5] 5 plants. [6] 2 plants. [7] Average of 50 plants.

The costs for labor at 28 plants and the total operating costs per 100 pounds of milk handled at 31 plants from which milk was shipped in tank cars are shown in table 9. Generally these plants were of greater capacity than those which shipped milk in cans by train or motortruck (table 7) or in tank trucks (table 8). At plants of similar capacity, the operating costs were slightly greater where tank cars were used than where tank trucks were used. One reason for this was that many of the plants which used tank cars were handling much less milk than could be handled economically. Another reason was that there was usually an additional handling of the milk. At many of the plants using tank trucks the milk was usually pumped directly to the trucks, and rarely into a storage tank (fig. 9). At practically all tank-car plants, however, the milk was stored in a storage tank until the arrival of the milk car, and this necessitated extra handling, also the cleaning of the storage tank. Most of the plants studied from which the milk was shipped in tank cars were much more elaborate and of more expensive construction than the plants from which the milk was shipped in tank trucks. Furthermore, at a considerable number of the latter plants only one man was required to operate the plant.

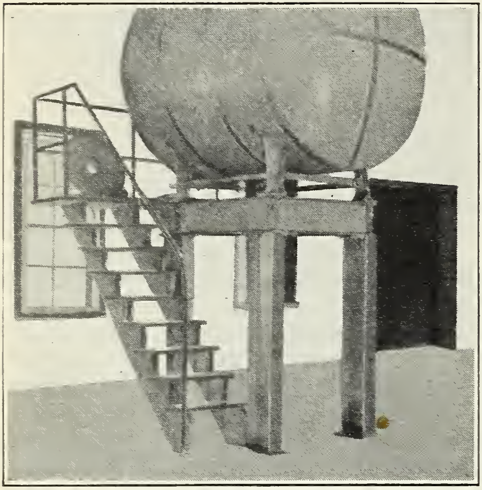

FIGURE 9.—Elevated milk-storage tank in receiving station shipping by tank truck. Storage tanks are more frequently used in plants shipping by tank car.

TABLE 9.—*Operating costs per 100 pounds of milk received at 31 receiving stations of various sizes from which the milk was shipped in tank cars*

Range of daily milk receipts (pounds)	Plants	Milk received daily per plant	Total operating cost per 100 pounds	Cost for labor only: Per 100 pounds of milk	Cost for labor only: Percentage of total operating cost
	Number	*Pounds*	*Dollars*	*Dollars*	*Percent*
20,000 to 30,000	8	26,251	0.1473	0.0714	51.3
30,001 to 40,000	8	34,749	.1444	[1].0549	[1] 42.2
40,001 to 50,000	7	46,512	.1383	.0575	38.5
Over 50,000	8	62,368	.1121	[2].0628	[2] 49.4
Total or average	31	42,339	.1356	[3].0623	[3] 45.4

[1] 7 plants. [2] 6 plants. [3] Average of 28 plants.

Here again, as in shipping milk by tank truck, or in cans (by truck or train) the costs for labor and the total operating costs per plant generally decreased as the volume of milk increased. The labor cost at the plants using tank cars (table 9) was approximately 50 percent of the total operating cost, except for the two groups of plants which handled between 30,000 and 50,000 pounds of milk daily. Most of the plants in those groups were of expensive construction, and the overhead costs were comparatively high. They were well-arranged plants, however, and the labor cost per 100 pounds was lower than the average for all the plants.

Table 10 shows the operating costs per 100 pounds of milk handled for 65 plants which were located in one milkshed. All milk was shipped in tank trucks. Fifteen of the plants did not use can washers or steam boilers, but used water heaters to heat water for cleaning utensils, etc. The equipment consisted of a water heater, weigh can and scales, receiving vat, milk pump, and tubular milk cooler. This explains why the costs at these plants were comparatively low, labor being the principal item of expense. Most of these plants were operated by one man, and the producers' cans were rinsed only. In most sections of the country steam boilers and can washers for cleaning the producers' cans are required by health officials. At the 50 plants which used steam boilers and can washers, the operating costs were slightly higher than at the plants using water heaters. In these plants both the cost of labor and the total operating costs per 100 pounds handled decrease as the size of the plants increases.

TABLE 10.—*Relation of volume to handling costs in one milkshed at 65 country receiving stations from which the milk was shipped in tank trucks*

Range of daily milk receipts (pounds)	Plants using steam boilers and can washers					Plants using water heaters—no boilers or can washers				
	Plants	Milk received daily per plant	Total operating cost per 100 pounds	Cost for labor only		Plants	Milk received daily per plant	Total operating cost per 100 pounds	Cost for labor only	
				Per 100 pounds of milk	Percentage of total operating cost				Per 100 pounds of milk	Percentage of total operating cost
	Number	*Pounds*	*Dollars*	*Dollars*	*Percent*	*Number*	*Pounds*	*Dollars*	*Dollars*	*Percent*
Less than 5,000	2	4, 353	0. 1537	--------	--------	3	3, 065	0. 1703	0. 1144	62. 2
5,001 to 8,000	8	6, 503	. 1360	--------	--------	4	7, 081	. 0689	. 0532	77. 2
8,001 to 10,000	12	8, 730	. 1302	0. 0761	56. 5	2	8, 899	. 0733	. 0461	62. 9
10,001 to 15,000	11	12, 968	. 1024	. 0564	46. 6	6	11, 255	. 0819	. 0552	67. 4
15,001 to 20,000	9	16, 988	. 0966	. 0562	45. 8	--------	--------	--------	--------	--------
20,001 to 30,000	8	24, 313	. 0884	. 0476	53. 8	--------	--------	--------	--------	--------

The costs for labor alone at 125 plants and the total operating costs per 100 pounds of milk received daily at 157 country plants using the 3 methods of shipping the milk, grouped according to the quantity of milk received daily are shown in table 11. Of these plants, 47 shipped milk in cans (by train or truck), 79 in tank trucks, and 31 in tank cars. With the exception of the group handling between 30,000 and 40,000 pounds a day, the total operating costs per 100 pounds and the costs for labor per 100 pounds decreased uniformly as the volume of milk handled increased. The percentages that the costs for labor were of the total operating costs likewise decreased with increasing volume.

TABLE 11.—*Operating costs per 100 pounds of milk received at 157 country receiving stations*

Range of daily milk receipts (pounds)	Plants	Milk received daily per plant	Total operating cost per 100 pounds	Cost for labor only	
				Per 100 pounds of milk	Percentage of total operating cost
	Number	*Pounds*	*Dollars*	*Dollars*	*Percent*
Less than 5,000	9	3, 613	0. 2785	[1] 0. 1813	[1] 61. 3
5,001 to 10,000	49	7, 711	. 1747	[2] . 0998	[2] 55. 8
10,001 to 20,000	53	14, 050	. 1426	[3] . 0802	[3] 53. 0
20,001 to 30,000	18	24, 839	. 1237	[4] . 0663	[4] 52. 4
30,001 to 40,000	10	34, 586	. 1569	[5] . 0690	[5] 42. 9
Over 40,000	18	55, 493	. 1204	[6] . 0566	[6] 44. 7
Total or average	157	18, 772	. 1565	[7] . 0860	[7] 52. 5

[1] 7 plants.
[2] 35 plants.
[3] 44 plants.
[4] 15 plants.
[5] 9 plants.
[6] 15 plants.
[7] Average of 125 plants.

The data on costs for labor and total operating costs given in tables 7, 8, 9, and 11 have been plotted graphically. In these graphs each plotted point represents the average for a group of plants of approximately the same size when grouped as shown in the four tables mentioned.

Figure 10 shows the operating costs per 100 pounds in relation to volume of milk handled, at plants grouped according to quantity of milk received daily. The slopes of the lines representing these costs drop very rapidly from the groups of smallest plants until an output of approximately 12,000 pounds daily is reached. From this point the slopes of the lines, with one or two exceptions, continue to drop, though more gradually. It will also be noted that the costs for plants shipping in cans were much greater than for those of similar sizes shipping in tank trucks. The line representing the costs at plants shipping in tank cars slopes down gradually as the size of the plants increases. These plants were of greater capacity than the plants which were using the other methods of shipping the milk.

Figure 11 shows the average costs for labor per 100 pounds of milk handled at plants grouped according to volume of milk received daily. The costs for labor are also expressed in percentages of the total operating costs. With few exceptions, the slopes of these lines drop as the size of the plant increased, and the drop is very pronounced from the group of smallest plants until a volume of approximately 15,000 pounds is reached.

In order to show more clearly the characteristic relationship of volume of milk handled to the costs for labor and the total operating costs per 100 pounds, the results that were being obtained at individual plants were then plotted for comparison. In these figures each point represents a single plant.

Figure 12 indicates the relation of volume handled per plant to operating costs at 47 individual plants from which the milk was being shipped in cans, and shows that the costs decreased very rapidly with increasing volume until an output of about 14,000 pounds was reached.

A similar trend was observed for plants shipping by other methods. Comparison of the data for individual plants for 79 plants shipping in tank trucks, 31 plants shipping in tank cars, and the 157 plants using the three methods of shipment, also indicated that the costs of operation tend to decrease with increasing volume of milk handled. In general the costs of operation decreased rapidly until an output of from 10,000 to 12,000 pounds was attained, depending on the type of plant, and from that point continued to decrease gradually as more milk was handled.

Comparisons were also made for individual plants to show the relationship of volume of milk handled per plant to labor costs per 100 pounds for 47 plants from which the milk was being shipped in cans; 50 plants (fig. 13) from which the milk was shipped in tank trucks; 28 plants from which the milk was shipped in tank cars; and for 125 plants (fig. 14) using the three methods of shipment. In all cases the per-unit labor cost tends to decline as the quantity of milk handled increases.

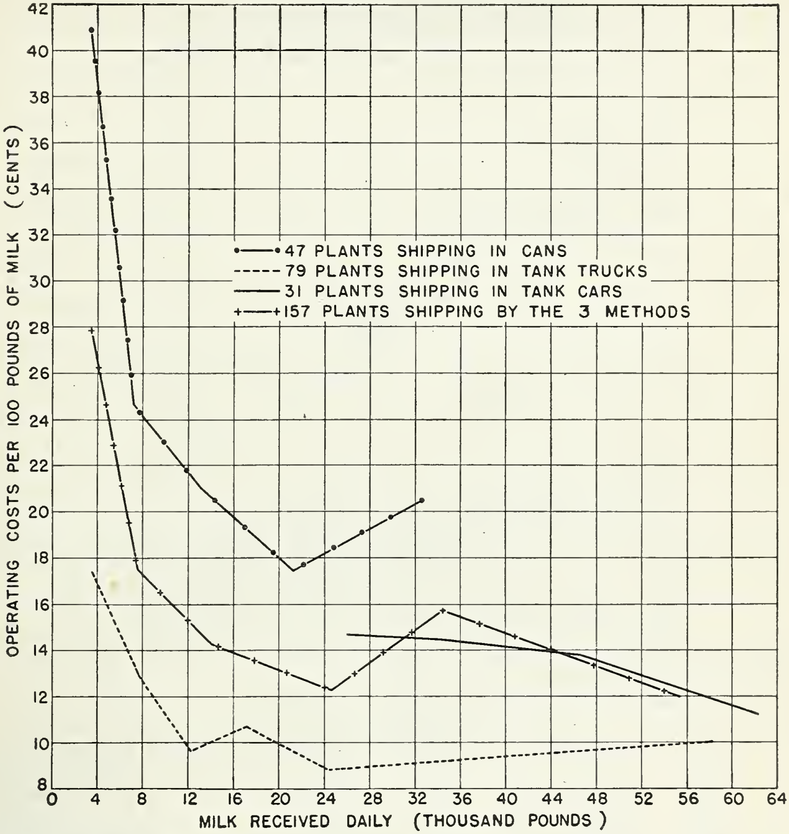

FIGURE 10.—Operating costs at plants using different methods of shipping the milk, grouped according to quantity of milk received daily.

DIVISION OF EXPENSES

The division of expenses for 1 year at four plants of one company where tank trucks were used exclusively to transport the milk to the city, is shown in table 12. The costs at plant 3 were exceptionally low. This plant was comparatively small in relation to the quantity of milk handled, but it was conveniently arranged and was operated by one man and a helper. The building was of hollow-tile construction, and the expenses for repairs and taxes were especially low.

On the other hand, the operating cost per 100 pounds of milk handled at plant 4 was relatively high, being more than twice as much as that at plant 1, where the volume was twice as great. Other factors contributed to this high cost besides the comparatively small volume handled. Plant 4 had a capacity much greater than the quantity of milk that was being handled. This increased the per-unit costs of such items as labor, fuel, and power. The building was rented at a rather high rental. The company expected to buy the building as soon as the volume of milk was high enough, and had expended a considerable amount for repairs.

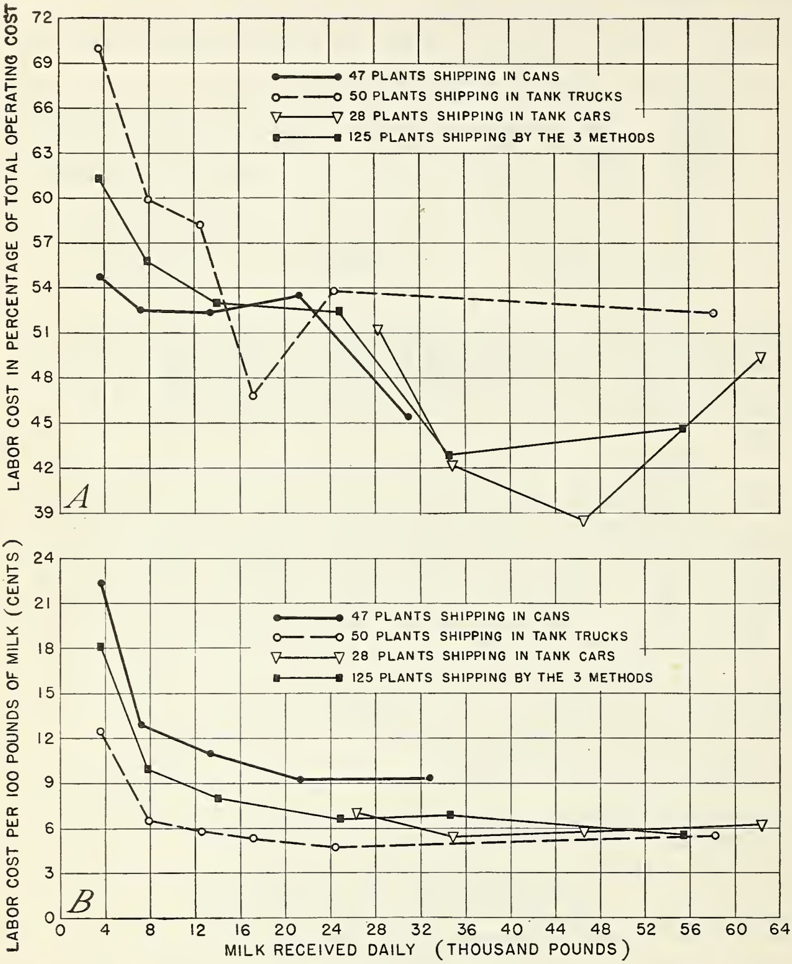

FIGURE 11.—Labor costs as percentage of total operating costs (*A*) and per 100 pounds of milk (*B*), at plants using different methods of shipping the milk, grouped according to quantity of milk received daily.

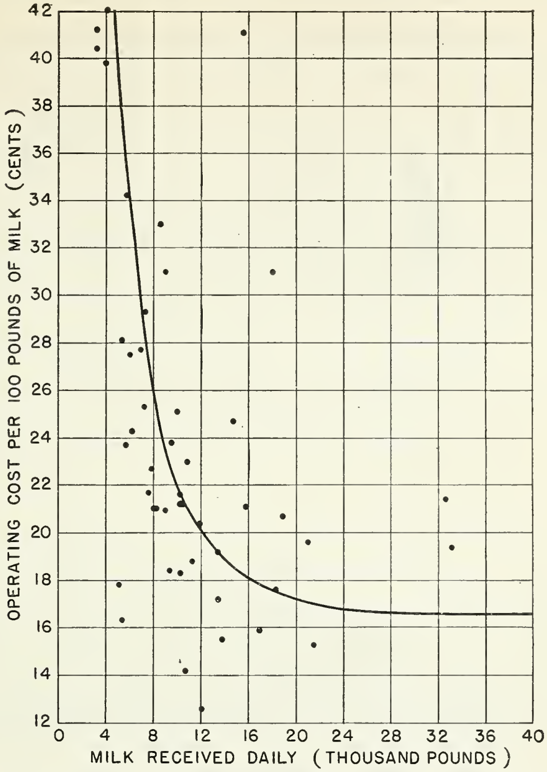

FIGURE 12.—Relation of volume of milk received per plant to operating costs per 100 pounds at 47 plants shipping in cans.

TABLE 12.—*Milk handled and division of operating expenses for 1 year at four plants from which the milk was shipped in tank trucks*

Item	Expenses for plant 1, handling 6,537,400 pounds of milk			Expenses for plant 2, handling 6,229,600 pounds of milk		
	Per year	Per 100 pounds	Percent	Per year	Per 100 pounds	Percent
	Dollars	*Dollars*		*Dollars*	*Dollars*	
Oil and ammonia	17. 15	0. 0003	0. 3	223. 47	0. 00358	3. 2
Fuel	590. 10	. 0090	10. 0	1, 103. 20	. 01771	15. 5
Power and light	733. 88	. 0112	12. 5	116. 28	. 00187	1. 6
Repairs	840. 70	. 0129	14. 3	1, 324. 01	. 02125	18. 6
Rent and taxes	42. 76	. 0007	. 7	270. 10	. 00434	3. 8
Salaries and wages	3, 242. 32	. 0496	55. 1	3, 332. 92	. 05350	46. 8
Miscellaneous	419. 64	. 0064	7. 1	748. 12	. 01201	10. 5
Total	5, 886. 55	. 0901	100. 0	7, 118. 10	. 11426	100. 0

Item	Expenses for plant 3, handling 5,230,800 pounds of milk			Expenses for plant 4, handling 3,247,600 pounds of milk		
	Per year	Per 100 pounds	Percent	Per year	Per 100 pounds	Percent
	Dollars	*Dollars*		*Dollars*	*Dollars*	
Oil and ammonia	14. 60	0. 0003	0. 3	14. 55	0. 0004	0. 2
Fuel	526. 51	. 0101	12. 6	875. 38	. 0270	13. 4
Power and light	579. 45	. 0111	13. 9	724. 38	. 0223	11. 1
Repairs	310. 17	. 0059	7. 4	956. 22	. 0294	14. 6
Rent and taxes	30. 00	. 0006	0. 7	838. 18	. 0258	12. 8
Salaries and wages	2, 380. 77	. 0455	57. 1	2, 593. 75	. 0799	39. 7
Miscellaneous	331. 99	. 0063	8. 0	538. 28	. 0166	8. 2
Total	4, 173. 49	. 0798	100. 0	6, 540. 74	. 2014	100. 0

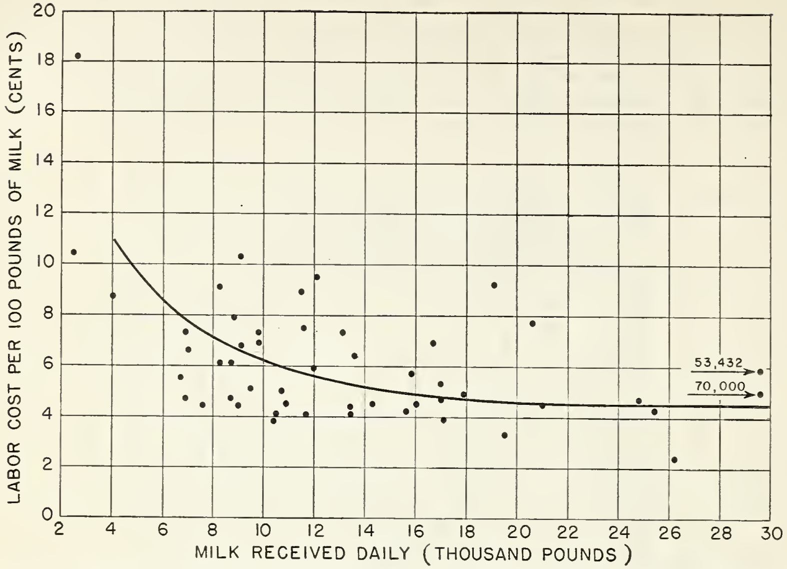

FIGURE 13.—Relation of volume of milk received per plant to labor costs per 100 pounds at 50 plants shipping in tank trucks.

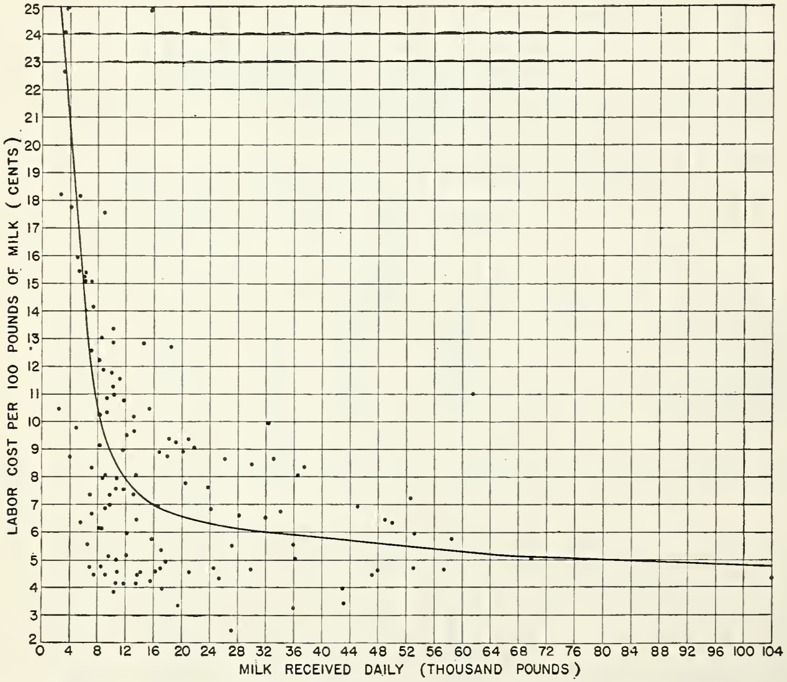

FIGURE 14.—Relation of volume of milk received per plant to labor costs per 100 pounds at 125 plants using three methods of shipment.

The division of expenses for 20 country receiving stations operated by one organization using tank trucks were as follows for 1 year:

	Percent
Ammonia and oil	0. 7
Coal	7. 7
Tank repairs	1. 4
Ice	4. 6
Power	3. 7
Rent	[1] 1. 1
Repairs	4. 7
Office salaries	4. 4
Salaries of superintendents	9. 7
Wages	29. 4
Laboratory expense	3. 4
Automobile expense and travel	13. 4
Insurance	3. 5
Taxes	1. 3
Stationery	. 4
Telephone	2. 4
Miscellaneous	8. 2
	100. 0

[1] The buildings and equipment at most of the plants were owned by the organization.

COAL REQUIRED TO OPERATE PLANTS OF VARIOUS SIZES

The quantity of coal required at 86 plants grouped according to the amount of milk handled daily is shown in table 13, and indicates that fuel is used more efficiently in the larger plants than in the smaller ones. Proportionally as much coal is required to get up steam at the beginning of the day in a small plant as in a large one.

TABLE 13.—*Coal used at plants of various sizes* [1]

Range of daily milk receipts (pounds)	Plants	Milk received daily per plant	Coal used daily	
			Per plant	Per 100 pounds of milk handled daily
	Number	*Pounds*	*Tons*	*Pounds*
10,000 or less	18	7, 461	0. 24	6. 4
10,001 to 20,000	35	15, 549	. 45	5. 9
20,001 to 40,000	24	26, 541	. 58	4. 3
Over 40,000	9	55, 222	1. 20	4. 1
All plants	86	21, 077	. 51	5. 4

[1] Plants using steam engines for power are not included.

The quantity of coal used at 50 plants from which the milk was shipped in cans and at 36 plants from which the milk was shipped in tanks is shown in table 14. The results for plants of all sizes indicate that more coal was used per 100 pounds of milk handled where the milk was shipped in cans than where tanks were used, doubtless because considerable coal is used for heating water to wash and steam the cans. Plants using tanks have no shipping cans to be washed, although some fuel is required for heating water to clean the milk-storage tanks or trucks. That fuel is used more economically in the larger plants of both types than in the smaller plants is shown in table 14.

TABLE 14.—*Coal used at plants using two systems of shipping milk* [1]

Range of daily milk receipts (pounds)	Plants shipping milk in cans				Plants shipping milk in tanks			
	Plants	Milk received daily per plant	Coal used daily		Plants	Milk received daily per plant	Coal used daily	
			Per plant	Per 100 pounds of milk handled			Per plant	Per 100 pounds of milk handled
	Number	*Pounds*	*Tons*	*Pounds*	*Number*	*Pounds*	*Tons*	*Pounds*
10,000 or less	11	7, 055	0. 24	6. 9	7	8, 114	0. 24	5. 5
10,001 to 20,000	25	14, 968	. 48	6. 6	10	17, 000	. 36	4. 2
20,001 to 40,000	10	26, 560	. 59	4. 5	14	26, 527	. 54	4. 1
Over 40,000	4	51, 200	1. 10	4. 2	5	58, 400	1. 30	3. 9
All plants	50	18, 448	. 50	6. 1	36	24, 727	. 54	4. 4

[1] Plants using steam engines for power are not included.

MEN REQUIRED TO OPERATE PLANTS OF VARIOUS SIZES

The average number of men employed at country receiving stations of various sizes is shown in table 15. Data are given for 72 plants from which the milk was shipped in cans, and 121 plants from which the milk was shipped in bulk in either tank trucks or tank cars. The average quantity of milk handled per man employed at the various sized plants is also shown.

TABLE 15.—*Labor employed at 193 plants*

Range of daily milk receipts (pounds)	Plants shipping in cans				Plants shipping in tanks			
	Plants	Milk received daily per plant	Men per plant	Milk handled per man	Plants	Milk received daily per plant	Men per plant	Milk handled per man
	Number	*Pounds*	*Number*	*Pounds*	*Number*	*Pounds*	*Number*	*Pounds*
5,000 or less	5	3, 681	1. 4	2, 743	5	3, 580	1. 0	3, 580
5,001 to 10,000	11	6, 886	2. 7	2, 992	33	7, 874	1. 2	7, 000
10,001 to 15,000	14	12, 417	3. 1	3, 871	21	12, 609	1. 3	10, 417
15,001 to 20,000	22	17, 621	4. 0	4, 563	18	16, 566	1. 6	12, 186
20,001 to 30,000	10	23, 799	4. 9	5, 166	20	24, 472	2. 5	10, 149
30,001 to 50,000	7	36, 129	6. 1	6, 253	13	40, 400	3. 9	11, 825
Over 50,000	3	58, 700	10. 0	6, 055	11	72, 273	4. 9	15, 701

It will be noted that as a general rule the larger the plant the more milk is handled per man employed, hence labor in country plants can be used more economically in large than in small ones. Fewer men are used per plant of similar capacity, and more milk is handled per man employed at the plants from which the milk is shipped in tanks than at those plants where cans are used. Much extra labor is required to wash the cans, draw the milk into them, and load them on the car or truck.

TIME AND LABOR REQUIRED TO RECEIVE THE MILK

TIME REQUIRED TO RECEIVE AND WEIGH MILK

The receiving-room operations consist of dumping the milk from the producers' cans into the weigh can, recording the weights, taking a sample for the butterfat test, and washing the cans. The time required to receive the milk at 155 plants of various sizes is shown in table 16. The period used is the total time during which milk is received and includes any time consumed in waiting for the producers' trucks to arrive, except in a few cases where one or two trucks would arrive 1 or 2 hours after the bulk of the milk was received. In such cases the men who receive the milk usually did other work during the waiting period and this time was deducted. In some sections all milk must be received before a certain hour in order to comply with the board-of-health requirements of the cities to which the milk is shipped. Where such requirements were in effect the most usual periods for receiving the milk were between 6 and 8 a. m. or between 6:30 and 9 a. m. It is desirable that all milk be received within a period of not over 4 hours at the larger plants and not over 2 hours at the smaller plants.

Table 16.—*Time required to receive milk at plants of various sizes*[1]

Range of daily milk receipts (pounds)	Plants	Milk received daily per plant	Time required to receive the milk			Milk received per hour	Time required to receive 1,000 pounds of milk
			Average	Most common	Range		
	Number	*Pounds*	*Hours*	*Hours*	*Hours*	*Pounds*	*Minutes*
10,000 or less	35	7,013	2.5	2.5	1.0 to 5.0	2,980	22.59
10,001 to 20,000	52	15,346	2.8	2.5	1.5 to 4.8	5,841	11.39
20,001 to 40,000	47	28,809	3.7	3.5	1.8 to 6.0	8,055	7.81
Over 40,000	21	59,952	4.3	4.0	3.0 to 6.0	14,230	4.60
All plants	155	[2] 23,590	[2] 3.2	2.5	1.0 to 6.0	[3] 7,776.5	[3] 11.60

[1] Includes time spent in weighing the milk and washing producers' cans.
[2] Weighted average.
[3] Average of groups.

LABOR REQUIRED IN RECEIVING ROOM

The average number of men and amount of labor used for receiving and weighing the milk and washing the producers' cans at 155 plants are shown in table 17. An average of slightly less than two men were required at the smaller plants and slightly less than three men at the larger plants. At a considerable number of the smaller plants, especially those from which the milk is shipped in tanks, only one man was employed to operate the plant. In many cases where there was only one man in the receiving room the producers or truck drivers would assist in washing the cans. Many plants were so arranged that as the cans of milk were received on a conveyor, the milk was dumped into the weigh can and the cans were placed directly into the can washer without extra handling. The washed cans passed directly to the producer's truck. At other plants more steps by the operator and more handling were necessary because of a less efficient arrangement of the equipment.

That labor is used much more efficiently in the receiving rooms of the larger plants is also shown in table 17.

TABLE 17.—*Labor required to receive milk at plants of various sizes* [1]

Range of daily milk receipts (pounds)	Plants	Milk received daily per plant	Men per plant	Hours per plant	Man-hours per plant	Milk received per man-hour	Labor required to receive 1,000 pounds of milk
	Number	*Pounds*	*Number*	*Number*	*Number*	*Pounds*	*Man-hours*
10,000 or less	35	7,013	1.3	2.5	3.2	2,524	0.48
10,001 to 20,000	52	15,346	1.9	2.8	5.1	3,335	.34
20,001 to 40,000	47	28,809	2.4	3.7	8.7	4,063	.30
Over 40,000	21	59,952	2.7	4.3	11.9	5,652	.20
All plants	155	[2] 23,590	[2] 2.0	[2] 3.2	[2] 6.7	[3] 3,893.5	[3] .33

[1] Includes weighing the milk and washing producers' cans.
[2] Weighted average.
[3] Average of groups.

CONSTRUCTION OF BUILDINGS

MATERIALS

The material used in the construction of buildings depends somewhat on local conditions. The principal factors to be considered are durability, upkeep, and initial cost. Brick, concrete, stone, and tile have some advantages over wood. They are more nearly fireproof, are usually warmer in winter and cooler in summer, and the cost of upkeep and repairs is comparatively low. Frame buildings, however, cost considerably less and, although the cost for upkeep and repairs is much greater, this type of construction is very popular because of the lower initial investment required. The materials used at 139 plants, grouped according to size of plant, are shown in table 18.

TABLE 18.—*Material used in construction of 139 country receiving stations*

Range of daily milk receipts (pounds)	Frame		Brick		Cement block		Hollow tile	
	Plants	Milk handled per plant	Plants	Milk handled per plant	Plants	Milk handled per plant	Plants	Milk handled per plant
	Number	*Pounds*	*Number*	*Pounds*	*Number*	*Pounds*	*Number*	*Pounds*
Less than 10,000	30	6,178	6	7,964	7	7,449	5	7,459
10,001 to 20,000	38	14,971	7	15,506	3	13,621	1	16,482
Over 20,000	17	26,051	6	26,213	4	32,188	2	48,250
Total or average	85	14,084	19	16,506	14	15,840	8	18,785

Range of daily milk receipts (pounds)	Frame and concrete		Stone		Steel and concrete		Brick and concrete	
	Plants	Milk handled per plant	Plants	Milk handled per plant	Plants	Milk handled per plant	Plants	Milk handled per plant
	Number	*Pounds*	*Number*	*Pounds*	*Number*	*Pounds*	*Number*	*Pounds*
10,001 to 20,000	4	13,872	1	15,900	1	12,000	1	19,000
Over 20,000			3	36,833	3	55,907		
Total or average	4	13,872	4	31,600	4	44,930	1	19,000

Frame buildings were the most common for plants of all sizes. Frame construction was used for 63 and 68 percent, respectively, of all plants in the two groups of smallest plants, and for 49 percent of all the plants in the group of largest plants. Brick and cement block were the two next most popular materials used, and were used in plants of all sizes. Hollow tile was also used in plants of all sizes, but only 5.8 percent of all plants used this material. A combination of brick and concrete was used in one plant, and the more expensive materials—stone, and combinations of steel and concrete—were used only in eight of the larger plants.

FLOORS

Floors must be of a hard-surfaced material to resist wear, and they should also be as waterproof and smooth as possible. Concrete is the most common material used and makes a satisfactory floor. Concrete floors should be laid on a good solid foundation and should be at least 3½ inches thick. Drains should be located when the floor is laid, to insure a correct slope of floor, and they should be properly trapped to prevent escape of sewer gas. The slope of the floor should be about one-fourth inch per foot toward the floor drains. The drains should be from 6 to 8 inches wide and have perforated removable covers. Tile floors are more acid-resistant than concrete and also will stand wear better. They are seldom found, however, in country receiving plants, probably because of the extra cost. The materials used for floors at 178 country receiving stations were as follows:

Material used:	*Number of plants*
Concrete	173
Iron plates and concrete	2
Iron grating and concrete	1
Red tile	1
Wood	1

INSIDE WALLS AND CEILINGS

For inside walls and ceilings, it is desirable to use a material that will provide a smooth, easily cleaned, durable, and waterproof surface. The materials used for inside wall surfaces at 186 plants were as follows:

Material used:	*Number of plants*
Wood	85
Plaster	49
Inside surface of brick	15
Cement	11
Inside surface of concrete blocks	8
Glazed tile or brick	6
Cement plaster	4
Inside surface of hollow tile	3
Composition wallboard	2
Inside surface of concrete	2
Metal	1

Wood walls are the most common and are usually of matched lumber or sheathing. Such walls should be kept well painted with a paint that is as near water- and steam-resistant as possible. Ordinary plaster is the next most common material. In some cases, the plaster was applied directly to the inside surfaces of brick or hollow-tile walls. Where plaster was used for the inside surfaces of frame buildings it was applied to wooden or metal laths. Cement plaster is much more satisfactory than ordinary plaster, as it will more readily withstand moisture and steam. It is, however, much more difficult to apply and was used at only four plants. The inside surfaces of brick, hollow tile, or concrete blocks are often used as the interior wall finish when these materials are used for the walls of the building. In many cases these surfaces are painted or whitewashed. At the plants constructed of these materials, cement applied directly to the inside surfaces makes a very satisfactory wall finish. At some of the larger plants glazed tile or brick was used for the inside walls. These materials are expensive and were used at only six plants. Concrete extending 6 or 8 inches above the floor level where wood or plaster walls are used will facilitate cleaning and help protect the walls from moisture and consequent deterioration.

As a rule ceiling finishes similar to those used for inside walls are found. The materials used for ceilings at 184 country receiving stations were as follows:

Material used:	*Number of plants*
Wood	136
Plaster	29
Cement	10
Metal	5
Cement plaster	2
Composition board	2

Wood ceilings are the most common. These were usually of matched lumber or sheathing. Wood ceilings should be kept well painted. In some of the smaller plants, the ceiling was formed by the roof. As in the case of inside walls, ordinary plaster was the next most common material used. Metal ceilings, as galvanized iron, are fairly satisfactory if kept well painted to prevent rusting, but they do not hold the paint well and were used at only five plants. Cement applied directly to the concrete of the floor above comprised the ceilings at 10 plants.

VENTILATION

Good ventilation is essential for all milk plants. A survey of 154 country plants showed that 108 had roof ventilators (fig. 15) 20 plants had skylights or cupolas, and 26 small plants depended on windows and doors for ventilation. Many plants had skylights or cupolas in addition to the roof ventilators (fig. 16). Roof ventilators connected to the milk-handling rooms by flues are satisfactory. This system of ventilation is similar to that used in dairy barns. The exhaust steam from the can washer should be piped directly out of the building, either through the roof or the side of the building.

ARRANGEMENT OF PLANT

In general the plant should be so laid out that the milk can be weighed in at one side of the building and shipped out from the opposite side.

As the milk arrives it is dumped into the weigh can, the weights are recorded, and samples taken for the butterfat test. Then the milk is released and flows to the receiving vat below, from which it may be pumped over a surface cooler or through an internal tubular cooler. The latter type of cooler is often used where the milk is shipped in tanks. The milk is pumped through the cooler direct to the tank truck or tank car, or else to a storage tank in the plant from which it later flows by gravity to the tank truck or car. Where milk is shipped by rail, the tracks are usually on the side of the plant opposite where the milk is received. At plants where the milk is shipped in cans, the

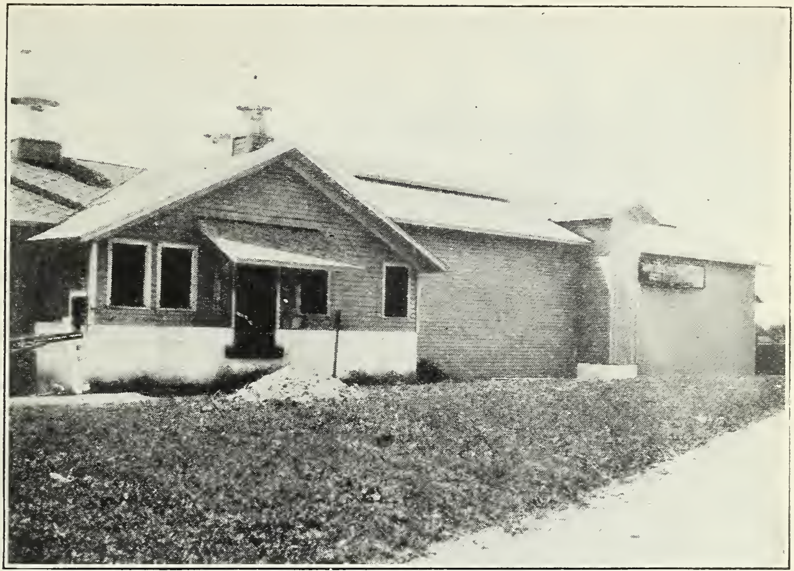

FIGURE 15.—Country receiving station with ice house (at right). Note roof ventilators, also neat frame construction.

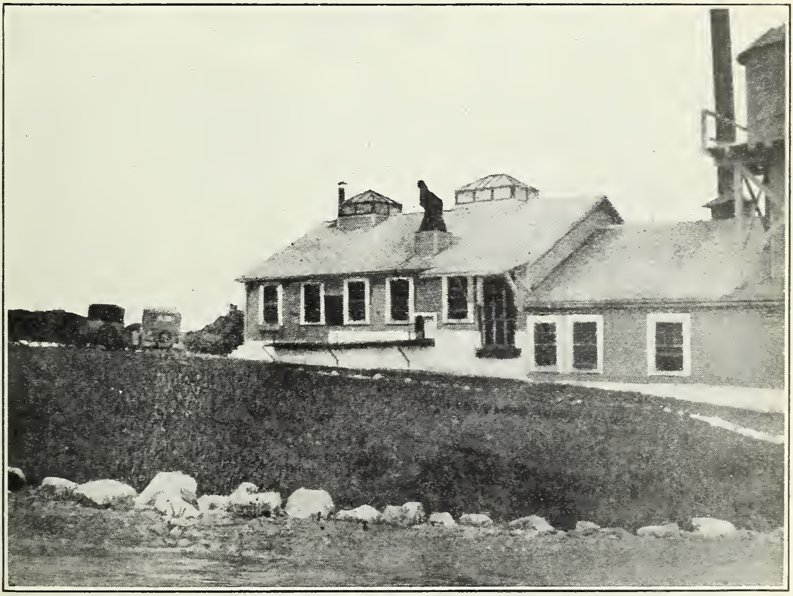

FIGURE 16.—Country receiving station with attractive yard. Note roof ventilators and skylights.

cans are usually filled directly from the surface cooler and are sent on conveyors out of the plant either to motor trucks or railroad cars, or into storage if the motor trucks or railroad cars have not arrived.

Ample storage space for supplies, etc., should be provided at the plant, in a room separate from that in which the milk is handled.

RECEIVING ROOM

The receiving deck where the milk is received and weighed should be about level with the floor of a motortruck, or about 3½ to 4 feet high, so that the incoming cans of milk can be easily unloaded from the truck. If a conveyor is used, the receiving floor should be lower than the truck floor by the height of the conveyor. The receiving room should be so arranged that the truck driver can unload his milk at the receiving door, and then drive on and receive his washed cans either from another door (fig. 17) or from a conveyor leading from the can washer (fig. 18). The can washer may be in this or in an adjoining room. The distance from where the milk is unloaded to where the cans are picked up should be far enough to avoid undue congestion when large and small loads follow each other closely. This condition can be taken care of by a conveyor which leads from the can washer out of and alongside of the building for a sufficient distance.

Certain dimensions of a number of receiving stations are shown in table 19. While there was a great variation in these dimensions, the averages should be useful, since they show about what these dimensions should be as determined by the collective opinion of those constructing these plants.

Table 19.—*Variations in certain dimensions at country receiving stations*

Dimension	Plants	Range		Average	Median	Most common
		High	Low			
	Number	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
Height of receiving deck above the driveway or ramp	106	54	30	42. 2	42	42
Height of dump bar above receiving deck (or above conveyor if used)	59	38	6	20. 3	18	18
Height of receiving deck above handling-room floor	60	132	18	54. 9	54	48
Depth of receiving pits or wells, from receiving deck	27	108	24	53. 6	48	60 and 48
Width of receiving room or deck	83	204	48	115. 2	120	120
Distance from receiving-room door to weigh can at plants not using system shown in figure 23, *A* and *D*	51	144	24	111. 6	72	72
Distance from receiving-room door to weigh can at plants using system shown in figure 23, *A* and *D*	20	30	14	20. 0	18	18

The height of the dump bar above the floor or conveyor varied considerably, but the various averages were quite uniform. The most common height was 18 inches, which is the most convenient height, according to the concensus of opinion of the plant superintendents interviewed. With a bar 18 inches high the cans of milk can be dumped with a minimum of lifting. Of course, where a conveyor is used the bar should extend 18 inches above the top of the conveyor itself. Also, a higher dump bar would be required where the operator receives the cans of milk on a receiving shelf and dumps them directly, as illustrated in figure 23.

The most desirable difference between floor levels of the receiving room and of the handling room will depend upon the installation of the weigh can and the height of the receiving vat. The difference should be such that the milk will flow by gravity from the weigh can to the receiving vat, but there is no advantage in having it greater. Approximately 4½ feet is usually sufficient. In some plants this distance was much greater, but these were old plants, usually remodeled butter factories, and had considerable waste space.

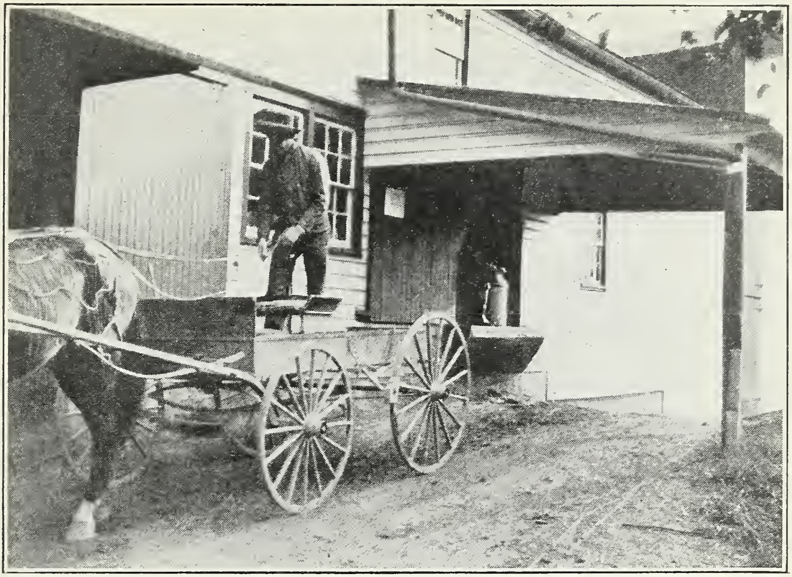

Figure 17.—Producer driving to can-delivery door after unloading his milk at receiving-room door.

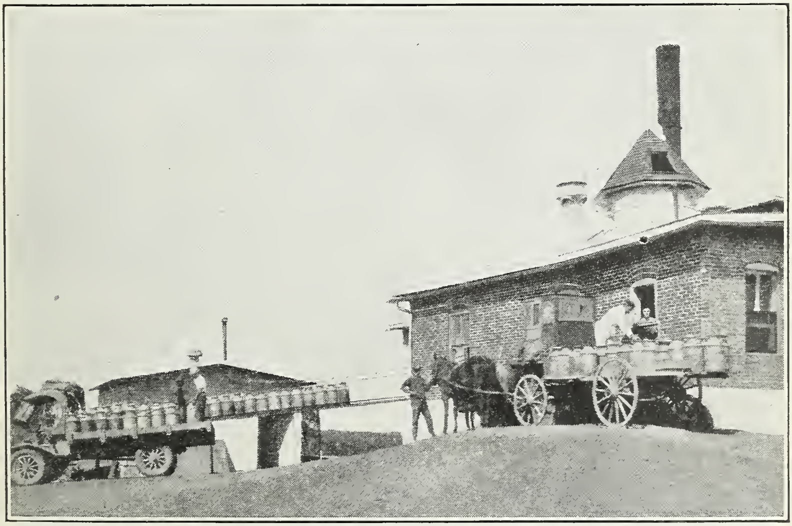

Figure 18.—Producers unloading milk and receiving clean cans at a large country receiving station.

At 27 plants, where the receiving vat was placed in a well or pit (fig. 19), its average depth was approximately 4½ feet. There is no

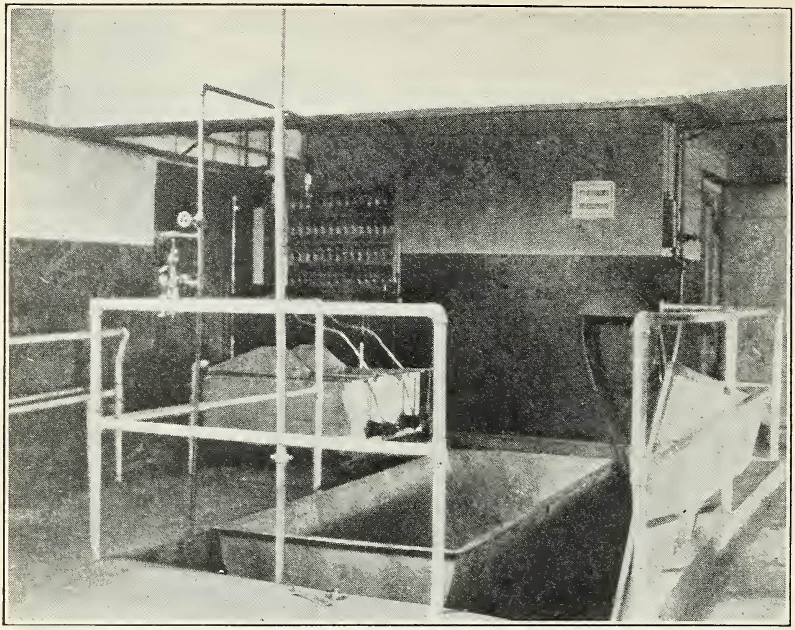

FIGURE 19.—Interior view in receiving room, showing two-compartment weigh can, receiving vat (in pit) and sample rack.

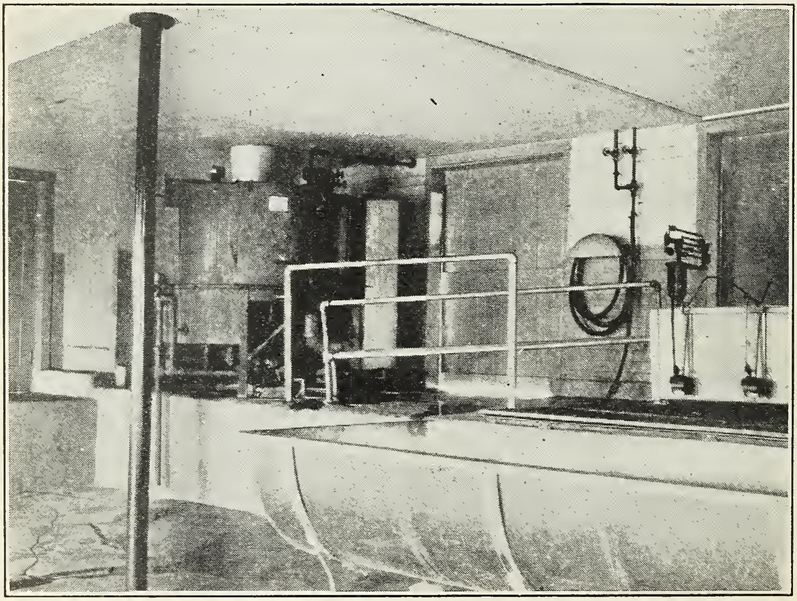

FIGURE 20.—Interior view in country receiving station, showing five-beam platform scales, weigh can, receiving vat, can drain rack, and rotary can washer.

advantage in having the pit over 4½ to 5 feet deep if one is used. If a pit is used, it is very important that it be large enough to allow plenty of room around the receiving vat and pump in order that the floor of the pit can be kept clean. Even then the pit is difficult to keep clean and should be avoided. A much more satisfactory arrangement is to set the receiving vat on the floor of the handling room (fig. 20) and have that floor well below the receiving deck, so as to avoid the necessity of a well or pit.

The width of the receiving room varied considerably for different plants, but the most common width was 10 feet. This allows enough room for receiving the milk and washing the producers' cans. At many plants the floor of the receiving deck is recessed to provide for the weigh can. The space occupied by this pit for the weigh can is approximately 4 feet, so that the distance from the receiving-room door to the weigh can is only about 6 feet. At 51 plants this latter distance ranged from 2 to 12 feet, the most common distance being 6 feet. A conveyor may be used to convey the cans of milk from the receiving-room door to the weigh can.

At 20 plants using the system of receiving milk illustrated in figure 23, *A* and *D*, the most common distance from the receiving "shelf" to the weigh can was 18 inches. In a survey of 132 plants it was found that conveyors were used at 50, the cans were rolled from the receiving-room door to the weigh can (usually a distance of from 4 to 6 feet) at 47 plants, and at 35 plants the system illustrated in *A* and *D*, was used with an average space for the operator of 20 inches.

The can washer should be so located that the cans may be placed directly in it by the man who dumps the milk, and a conveyor provided to carry the cans directly from the can washer out of the building. Where a rotary can washer is used, one man may put the empty cans into the machine and take out the washed cans and either pass them out directly to the trucks or place them on a conveyor leading outside.

Samples to be tested for butterfat are taken in the receiving room, and the testing is usually done either in the receiving room, or in a room connected directly with it.

MILK-HANDLING ROOM

The milk-handling room should be directly back of the receiving room, and should be so arranged that the milk can be shipped out on the side opposite to the receiving room (figs. 21 and 22). Although the milk-handling room should be adjacent to the receiving room it should be separate from it. As already stated, the handling floor should be sufficiently below the receiving deck for a gravity flow of the milk from the weigh can.

The receiving vat, milk pump, and milk cooler will be located in the handling room. Also, where shipments are made by tank truck or tank car, there will usually be a storage tank for the milk. This tank should be elevated so that the milk can be drawn from it by gravity to the truck or car.

Where milk is shipped in cans, the cans are usually filled direct from the milk cooler and sent out on a conveyor to the truck or car. If the milk has to be held for any length of time, a milk-storage room with mechanical cooling or ice must be provided.

Where milk is shipped in cans, a separate room should be provided for washing the shipping cans. This room should be adjacent to the milk-handling room and so located that the cans can be readily unloaded from the car or truck. At some small plants both the producers' cans and the shipping cans are washed in the same room (fig. 24).

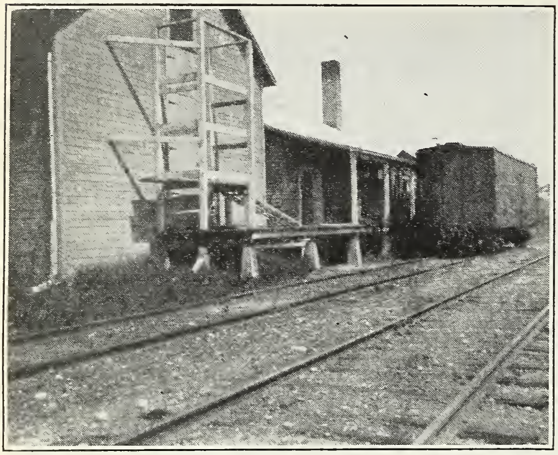

FIGURE 21.—Rear view of country receiving station from which the milk is shipped in cans by rail, showing milk car spotted at the plant.

Toilets, showers, etc., should be located away from the milk-handling rooms.

BOILER ROOM

The boiler room should be so located that dust or dirt from it cannot get into the milk-handling room. A small shed or lean-to is often provided for the boiler room. If the plant is located on a railroad siding, the boiler room and coal-storage bins should be so arranged that the coal can be conveniently unloaded direct from the car. The boiler room is often on a level below that of the milk-handling room.

The boiler room should be of fireproof construction and separate from the other rooms, but for economy of operation should be readily accessible from the workrooms. For small or medium-sized plants it is desirable that the boiler room be adjacent to the can-washing room enabling the man who washes the cans conveniently to look after the boiler (figs. 24, 25, and 26). In large plants a regular fireman or engineer is usually employed and the boiler room, refrigerating machine, etc., may be in one end of the plant away from the workrooms (figs. 28 and 29). Ample space for coal storage should be provided adjacent to the boiler room. Provision may be made in the boiler room for doing repair work.

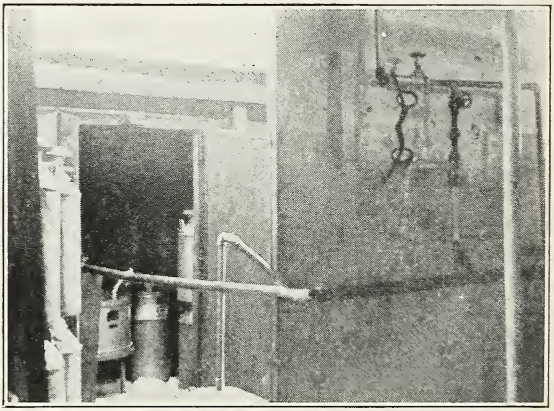

FIGURE 22.—Filling cans in milk car spotted at country receiving station.

Where mechanical refrigeration is not used, an ice house must be provided (figs. 15 and 27). Except in extreme northern sections of the country, however, mechanical refrigeration is generally used in country plants. The refrigerating machine may be located in the milk-handling room or in the boiler room or, as is customary at large plants, in a separate room.

COMPARISON OF DIFFERENT ARRANGEMENTS USED IN COUNTRY PLANTS

In figure 23 diagramatic sketches of sections through the receiving and handling room illustrate various arrangements of these rooms and of the equipment therein, as observed in country plants.

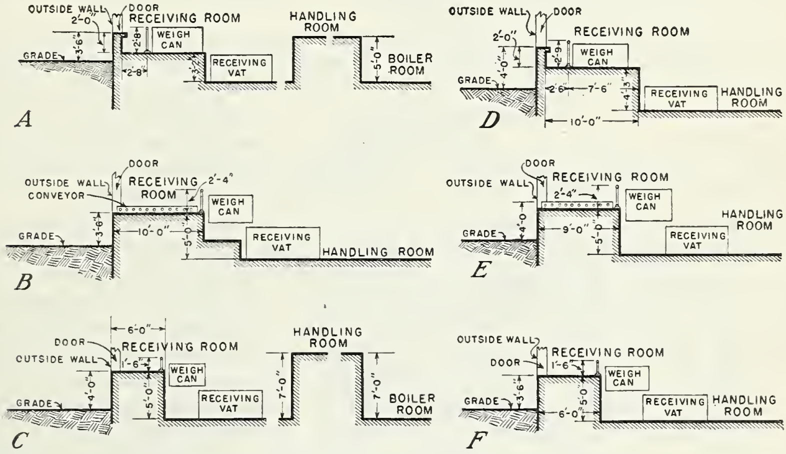

FIGURE 23.—Various arrangements of receiving and handling rooms and equipment: *A*, Shows use of receiving shelf; *B*, receiving deck partly recessed for weigh can; *C*, receiving vat in pit below handling-room floor; *D*, receiving vat on floor of handling room; *E*, use of conveyor; *F*, receiving deck wholly recessed for weigh can.

In plants arranged as in figure 23, *A* and *D*, the cans of milk are set on a receiving shelf by the truckman. The man who dumps the milk—usually the operator—stands in the small space between this shelf and the weigh can. After dumping the milk into the weigh can he either places the empty can in the can washer or passes it to another man who operates the can washer. Since the man who dumps the milk stands in one place and has to take practically no steps, he can dump the milk very rapidly. The milk must be dumped as fast as it arrives, as there is no space to store the cans of milk. It will be noted that with this system of receiving the milk the weigh can and dump bar are higher than with the other systems described. This is necessary because the cans of milk, as received, are set about 2 feet above the floor on which the operator stands. As shown in table 19, the space in which the operator stands between the receiving shelf and the weigh can at 20 plants varied from 14 to 30 inches, with 18 inches the most common distance. This system of receiving milk was found at 35 in a total of 132 plants.

The use of a pit in which the receiving vat is installed is shown in figure 23, *A*. This is also illustrated in *C*, with a different arrangement of the weigh can.

Figure 23, *B* and *E* illustrate the use of a conveyor for conveying the milk from the receiving-room door to the weigh can. This system saves labor at the larger plants. One man may remove the covers and inspect the milk, while another dumps the milk into the weigh can. Conveyors were used at 50 in a total of 132 plants. The dump bar is approximately 18 inches above the top of the can conveyor. Two different systems of arranging the weigh can and receiving vat are also illustrated in these two diagrams. In some plants, as in *B*, the end of the receiving deck where the scales and weigh can are installed is partly recessed for the installation of the weigh can. In still others, as in *E* and *F* this recess is cut down level with the handling-room floor. With this latter arrangement cleaning is more easily accomplished.

Figure 23, *C* and *F* illustrate arrangements for receiving the milk without the use of a conveyor, or a receiving shelf. The receiving bar is 18 inches above the floor. In *C* the receiving vat is in a pit 7 feet below the handling-room floor, while in *F* the more common arrangement of having the receiving vat on the handling floor is shown. In both lay-outs the floor of the receiving room is recessed all the way to the floor below to provide space for the weigh can.

In a survey of 132 plants the arrangement of the weigh can and receiving vat at 50 plants was similar to that illustrated in figure 23, *C*, *E*, and *F*. At 38 plants the arrangement was similar to that illustrated in *B*, and at 33 plants the scales and weigh can were placed on the floor of the receiving room with the receiving vat on the floor below, as illustrated in *A* and *D*. At 11 one-story-and-basement plants the receiving vat was directly under the weigh can on the floor below.

The boiler-room floor, as illustrated in *A* and *C*, is often on a level below that of the handling-room floor. Whether the boiler room should be on a level below the handling room will depend somewhat on the contour of the lot on which the plant is located.

FLOOR SPACE REQUIRED

The total amount of floor space at 50 plants from which the milk was shipped in tanks and at 43 plants from which the milk was shipped in cans is shown in table 20. The space used for ice storage at some plants which did not have mechanical refrigeration is not included. A considerable number of plants were omitted which had a large amount of waste space. Such plants were as a rule old creameries or old bottling plants.

TABLE 20.—*Floor space in plants of various sizes* [1]

Range of daily milk receipts (gallons) [2]	Plants shipping in tanks				Plants shipping in cans			
	Plants	Milk received daily	Average floor area		Plants	Milk received daily	Average floor area	
			Total	Per 100 gallons received daily			Total	Per 100 gallons received daily
	Number	*Gallons*	*Square feet*	*Square feet*	*Number*	*Gallons*	*Square feet*	*Square feet*
Less than 1,000	9	804	996	144.1	11	675	1,246	189.2
1,001 to 2,000	12	1,384	1,742	129.7	16	1,713	2,301	138.0
2,001 to 3,000	12	2,553	1,838	72.2	13	2,607	2,473	96.9
3,001 to 5,000	9	4,126	2,691	65.9	3	4,167	3,519	83.9
Over 5,000	8	7,775	4,140	51.7				

[1] Includes all space except that used for ice storage in plants not using mechanical refrigeration. Plant originally built for other purposes with large amounts of waste space are not included in this tabulation.

[2] In considering floor space and plant arrangement volume of milk is commonly expressed in gallons.

More space is required in plants of all sizes where milk is shipped in cans. As a rule, space for two can washers is required, one for washing the cans in which the milk is shipped to the city and one for producers' cans. For both types of plants the amount of floor area per 100 gallons handled decreases with the volume handled.

FLOOR PLANS

Floor plans developed by the Bureau of Dairy Industry[1] are presented as suggestions for designing the lay-out and arrangement of country milk-receiving and cooling stations of various sizes.

PLANT TO RECEIVE 300 TO 500 GALLONS OF MILK DAILY, THE MILK TO BE SHIPPED IN CANS

Figure 24 shows a suggested floor plan for a plant designed to receive and cool small quantities of milk ranging from 300 up to 500 gallons, or approximately 4,000 pounds, daily, from which the milk is to be shipped to the city in cans. A plant of this size should be constructed and arranged as simply as possible, with a view to addition or combination with another station as the volume of milk increases. This plant is so arranged that both the producers' and the shipping cans are washed in the same can washer. The floor level of the receiving room is 4 feet above the floor level of the rest of the plant. After the producers' cans are emptied, they are conveyed by gravity on a short conveyor to the can-washing room. The shipping cans, after being washed in this room, pass to the milk-handling room adjoining, where they are filled directly from the tubular cooler and then go out the rear door to the milk truck or car. The samples of milk are tested in the can-washing room adjacent to the receiving room.

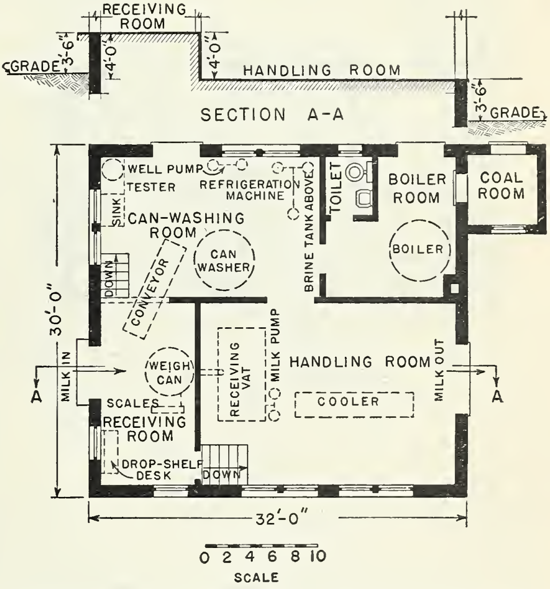

FIGURE 24.—Plan for a country milk-receiving and cooling station of 500 gallons daily capacity from which the milk is to be shipped in cans.

PLANT TO RECEIVE 300 TO 500 GALLONS OF MILK DAILY, THE MILK TO BE SHIPPED BY TANK TRUCK

Figure 25 shows a suggested floor plan for a plant to receive and cool from 300 to 500 gallons, or about 4,000 pounds, of milk daily, from which the milk is to be shipped by tank truck. After the milk is received and dumped into the weigh can, the cans are washed in the rotary can washer in the same room, and are sent out to the producers' trucks through the door near the washer. The milk is pumped from the receiving vat over the cooler, from which it is pumped to the tank truck or to a milk-storage tank. If an internal tubular cooler is to be used, the milk may be pumped through it from the receiving vat directly to the tank truck or to a milk-storage tank. Both the boiler room and the milk-handling room are readily accessible from the receiving room, and it is possible for one man to operate the plant, provided he gets some help from the producers in washing the cans.

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[1] Assistance was rendered by the Bureau of Agricultural Engineering, U. S. Department of Agriculture, in the preparation of these plans.

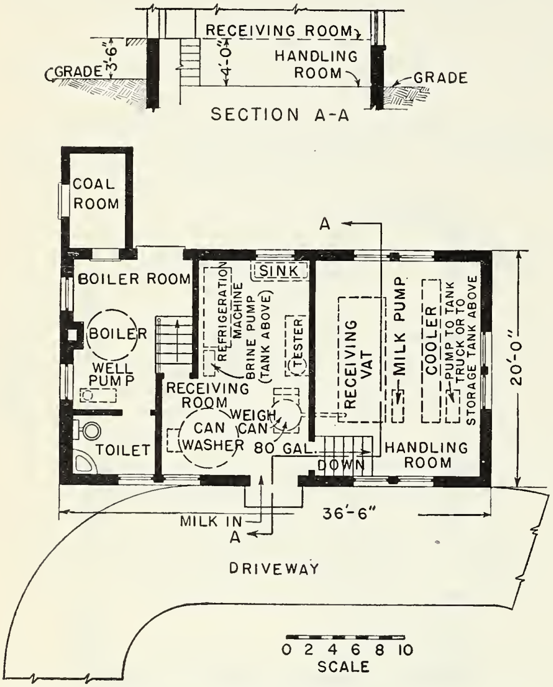

Figure 25.—Plan for a country milk-receiving and cooling station of 500 gallons daily capacity from which the milk is to be shipped in tank trucks.

PLANT TO RECEIVE 1,000 TO 1,500 GALLONS OF MILK DAILY, THE MILK TO BE SHIPPED IN CANS

Figure 26 shows a suggested floor plan for a plant to receive and cool from 1,000 to 1,500 gallons, or about 10,000 to 12,000 pounds, of milk daily and ship the milk in cans either by truck or rail. It will be noted that the can washer for the producers' cans is located in the receiving room, and that the test room and a small office adjoin the receiving room. The shipping cans are received either from trucks or railroad cars at the shipping platform, whence they are sent to the can-washing room. After being washed, the shipping cans go to the milk-handling room. The cans are filled directly from the tubular cooler, and are sent out to the shipping platform on a roller conveyor.

PLANT TO RECEIVE APPROXIMATELY 2,000 GALLONS OF MILK DAILY, THE MILK TO BE SHIPPED BY TANK CAR

A suggested floor plan for a plant to receive approximately 2,000 gallons, or between 15,000 and 20,000 pounds, of milk daily, and ship the milk by tank car, is shown in figure 27. The cans of milk are received on a short conveyor leading to the weigh can and, after being emptied, the cans are washed in the rotary can washer and sent to the producers' truck by means of a conveyor alongside of the building. The floor of the receiving room is recessed to provide for the weigh can and receiving vat as indicated in figure 23, *C* and *F*. From the receiving vat the milk is pumped through an internal tubular cooler either directly to the tank car or to a milk-storage tank overhead.

This plan is designed for a plant in which the milk is to be cooled by ice water, but could be readily modified for use of mechanical refrigeration. The tank for supplying ice water to be circulated through the milk cooler is adjacent to the ice house. If it is desired to use mechanical refrigeration, the ice house would be eliminated and the mechanical refrigerating equipment could be located in the room provided for the ice-water tank and well pump.

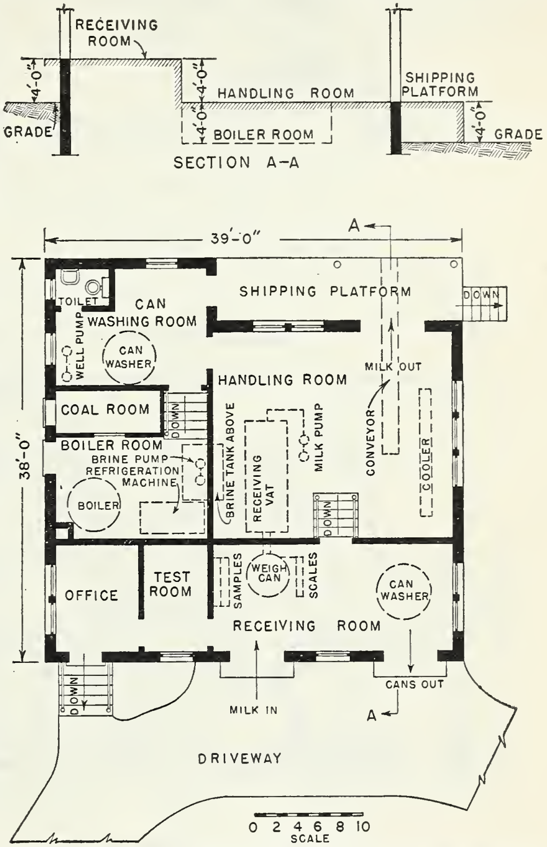

Figure 26.—Plan for a country milk-receiving and cooling station of 1,500 gallons daily capacity from which the milk is to be shipped in cans.

PLANT TO RECEIVE 2,000 TO 2,500 GALLONS OF MILK DAILY, THE MILK TO BE SHIPPED IN CANS

Figure 28 shows a suggested floor plan for a plant to receive and cool from 2,000 to 2,500 gallons, or about 20,000 pounds, of milk daily, to be shipped in cans by rail or truck. The milk is received on a conveyor leading to the weigh can, as in the plan shown in figure 27. The suspended type of weigh can is used. The floor of the receiving room may be recessed to provide for the weigh can if desired. The receiving vat is in the handling room. Either a rotary or straightaway can washer may be used, although a rotary washer is shown in the plan. The washed cans are sent out on a conveyor to the producers' trucks. Facilities for testing the milk are provided in the receiving room but this could also be done in a part of the space provided for the office. The shipping cans are received on the covered platform and are sent to the can-washing room. After the cans are washed they are sent to the milk-handling room where they are filled directly from the milk cooler. A roller conveyor may be provided for conveying the filled cans to the shipping platform. It will be noted that separate rooms are provided for the well pump, storage, and the compressor, as well as the boiler; also that the boiler room is on a level 4 feet below the level of the handling room.

PLANT TO RECEIVE 4,000 TO 6,000 GALLONS OF MILK DAILY, THE MILK TO BE SHIPPED IN TANK CARS

Figure 29 shows a suggested floor plan for a plant to receive and cool from 4,000 to 6,000 gallons, or approximately 40,000 pounds, of milk daily, to be shipped in tank cars. The arrangement for receiving the milk is similar to that indicated in figure 23, *A* and *D*, and scales of the suspended tank type are used. The man who dumps the milk places the empty cans in the straightaway can washer, which delivers them with the covers automatically replaced on them to the conveyor leading to the producers' trucks. From the receiving vat the milk is pumped through the internal tubular milk cooler either directly to the tank car or to the milk-storage tank overhead. A plant of this size would usually require the services of a regular fireman or engineer, so the boiler room need not be in close proximity to the receiving or milk-handling rooms. Either a horizontal return tubular boiler or an Economic type boiler (p. 51) could be used. It will be noted that the laboratory adjoins the receiving room and the office is adjacent to the milk-handling room. The plan is designed for a plant that may be entered from all four sides of the building.

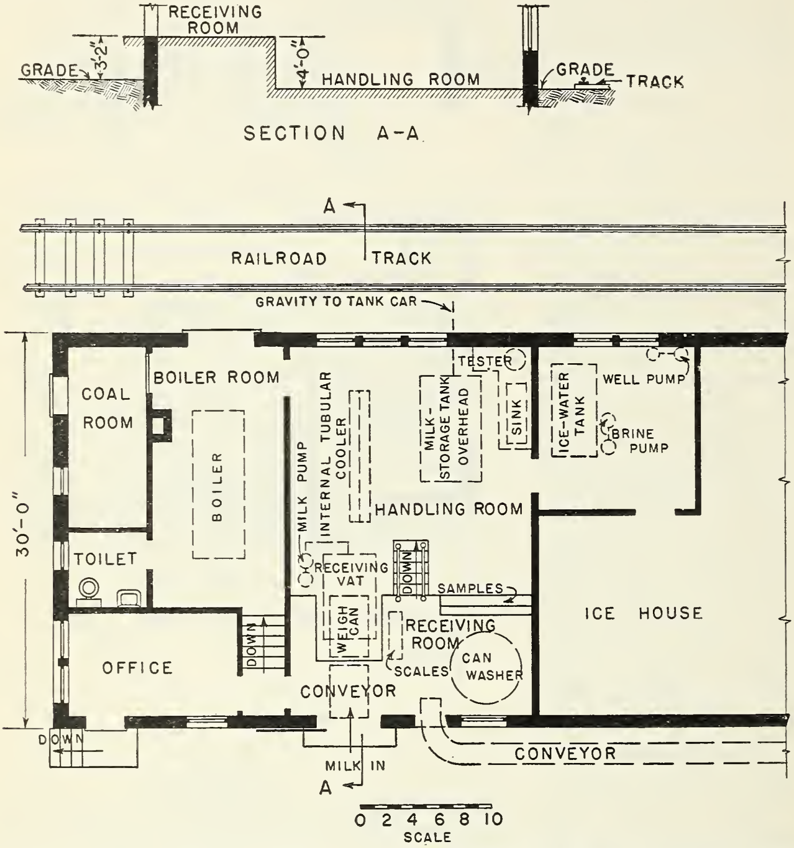

FIGURE 27.—Plan for a country milk-receiving and cooling station of approximately 2,000 gallons daily capacity from which the milk is to be shipped in tank cars. This plant is arranged for using ice, but mechanical refrigeration could be readily substituted.

EQUIPMENT FOR COUNTRY RECEIVING STATIONS

The principal items of equipment required for country receiving stations are as follows:

Weigh tank and scales.
Receiving vat with milk pump.
Milk cooler.
Milk-storage tank (where necessary).
Can washer.
Can filler (at can-shipping plants).
Boiler and accessories.
Refrigerating machinery, motors, etc.
Well pump.

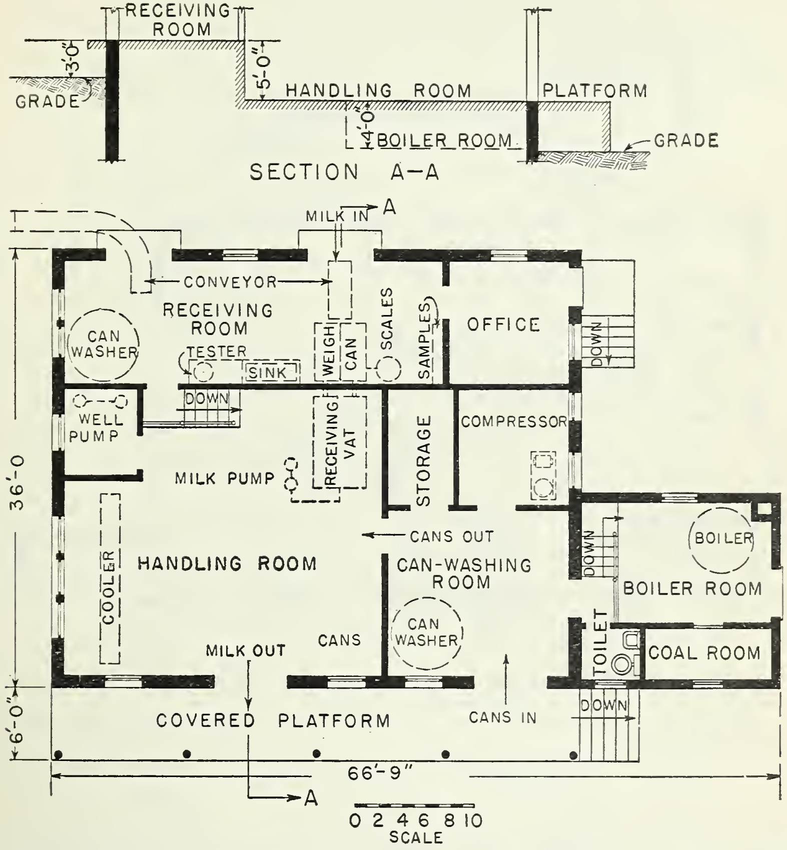

FIGURE 28.—Plan for a country milk-receiving and cooling station of 2,500 gallons daily capacity from which the milk is to be shipped in cans.

Types of equipment found at receiving plants of various sizes shipping the milk in cans and in tanks are indicated in table 21. Refrigerating equipment is discussed on pages 47 to 49, and boilers on pages 50 and 51.

SCALES

The types of scales used in 171 receiving plants are shown in table 21. Ordinary platform beam scales were used in many of the smaller plants, but rarely in the larger ones. Only six of the plants with these scales handled more than 20,000 gallons of milk daily. These scales may have from one to seven beams, but usually five- or seven-beam scales are used. With a five-beam scale (p. 33) the milk of five small producers may be weighed before any of the milk is released to the vat below. A few plants had beam scales with suspended tank. The latest type of scale has the automatic dial, the scale levers located overhead, and the tank suspended (fig. 30). It is a desirable type for plants of medium and large size, as the milk received can be dumped and weighed very rapidly. The automatic dial has the advantage that the operator can readily weigh the milk without manipulating any beam indicators; also the producer delivering his milk can observe its weight on the dial, and know that he is getting full credit for the quantity delivered.

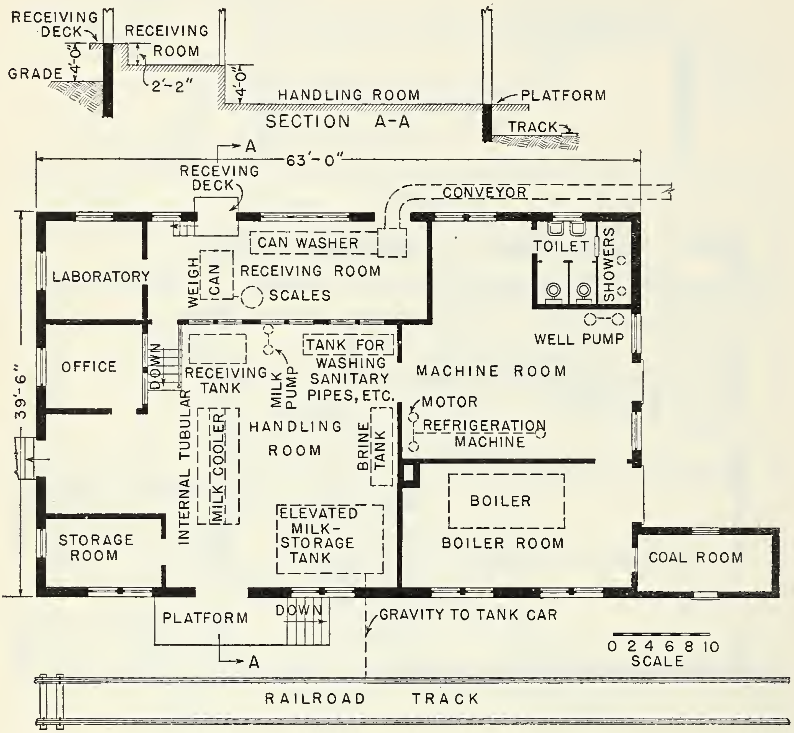

FIGURE 29.—Plan for a country milk-receiving and cooling station of 6,000 gallons daily capacity, from which the milk is to be shipped in tank cars

WEIGH TANK

Double-compartment weigh tanks (fig. 31) are used in most country receiving stations. With such tanks, one compartment can be filled while the other is draining, so that the milk can be weighed in faster than where a single-compartment weigh tank is used. At very small plants the single-compartment tank is satisfactory.

Whether single- or double-compartment weigh tanks are used the outlet valves to the receiving vat should be sufficiently large so that the milk will flow out quickly when the valves are released. These valves are usually from 6 to 10 inches in diameter. The weigh tanks usually hold from 600 to 1,000 pounds of milk.

TABLE 21.—*Types of equipment used at 171 plants of various sizes*

PLANTS SHIPPING IN CANS

Range of daily milk receipts (pounds)	Plants	Milk received daily per plant	Plants using specified types of—													
			Scales				Weigh tank		Milk pump from receiving vat to cooler [1]			Milk cooler [2]		Can washer [3]		
			Platform, beam	Suspended tank, beam	Platform, automatic	Suspended tank, automatic	Single compartment	Double compartment	Piston	Rotary	Centrifugal	Surface	Internal, tubular	Rotary, power	Straight-away, power	Rinser, steamer, and drier
	Number	*Pounds*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*
10,000 or less	19	7,155	15	------	2	2	8	11	15	3	------	16	3	10	------	9
10,001 to 20,000	36	16,361	12	7	7	10	6	30	30	2	3	28	8	14	6	16
20,001 to 30,000	12	24,875	4	2	3	3	2	10	10	2	------	6	6	9	2	1
30,001 to 40,000	7	34,643	------	------	1	6	2	5	5	1	1	7	------	4	1	2
Over 40,000	6	56,667	------	------	2	4	1	5	5	------	1	4	2	1	3	2
All plants	[1] 80	------	31	9	15	25	19	61	65	8	5	61	19	38	12	30

PLANTS SHIPPING IN TANKS

Range of daily milk receipts (pounds)	Plants	Milk received daily per plant	Platform, beam	Suspended tank, beam	Platform, automatic	Suspended tank, automatic	Single compartment	Double compartment	Piston	Rotary	Centrifugal	Surface	Internal, tubular	Rotary, power	Straight-away, power	Rinser, steamer, and drier
10,000 or less	23	7,670	6	------	13	4	6	17	10	10	3	22	1	10	1	5
10,001 to 20,000	24	15,896	1	1	7	15	9	15	13	8	3	21	3	11	4	2
20,001 to 30,000	18	25,011	------	2	------	16	5	13	14	2	2	13	5	13	5	------
30,001 to 40,000	9	37,111	1	1	1	6	1	8	5	------	4	5	4	2	7	------
40,001 to 60,000	11	50,636	1	------	2	8	1	10	6	2	3	4	7	1	10	------
Over 60,000	6	91,500	------	------	------	6	------	6	3	------	3	3	3	------	6	------
All plants	[3] 91	------	9	4	23	55	22	69	51	22	18	68	23	37	33	7

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[1] 2 of the 80 plants shipping in cans had no milk pump, but the milk flowed by gravity from the receiving vat over the cooler on a floor below.

[2] 1 plant had a special cooler.

[3] 14 of the 91 plants shipping in tanks had no can washer, the producers' cans being rinsed only.

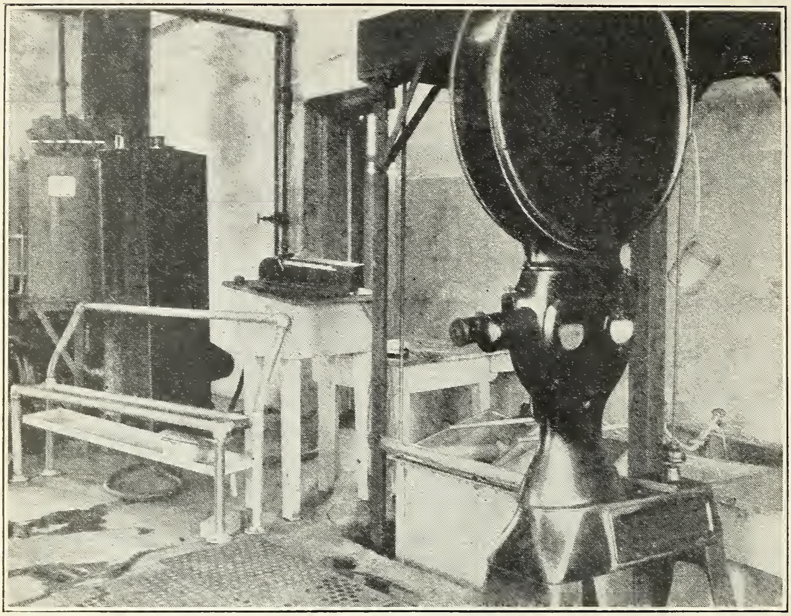

FIGURE 30.—Interior view in receiving room, showing two-compartment weigh can suspended from automatic scales (at right), can drain rack, can washer (at left), and machine for recording weights (on table in center).

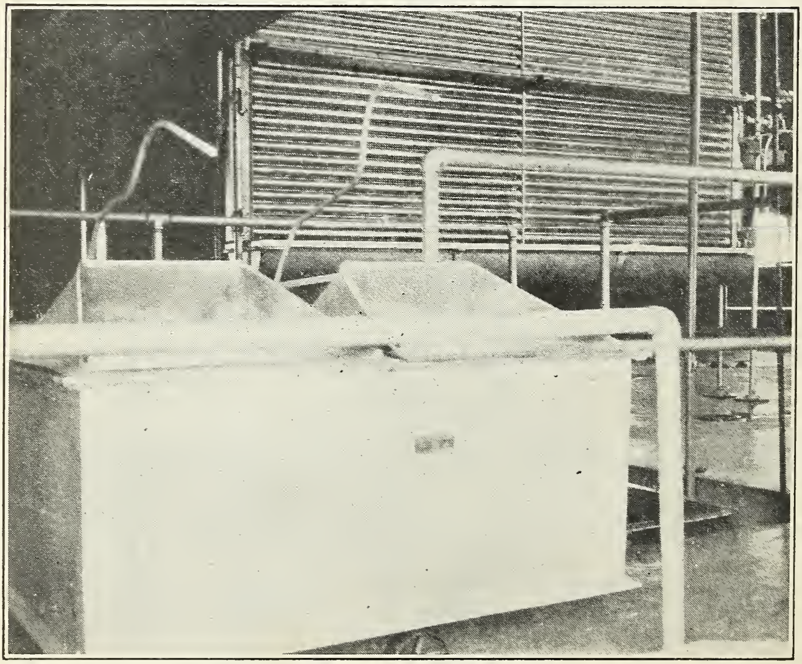

FIGURE 31.—Weigh can and surface cooler in country receiving station. Note dump bar, slightly higher than weigh can.

RECEIVING VAT

From the weigh tank the milk flows to the receiving vat, located below. This vat should be covered, and should be large enough to hold a surplus of milk when the pump is not taking the milk away to the cooler as fast as it is weighed in. Receiving vats ranged in size from 50 gallons at small plants to 1,000 gallons at some large plants using internal tubular coolers and shipping the milk in tanks. Receiving vats are illustrated in figures 19 and 20.

MILK PUMPS

Milk pumps are used to pump the milk from the receiving vat over or through the cooler. In some plants a pump is also used to pump the milk from the surface cooler to a storage tank. Pumps are also required at some plants to pump the milk from the milk-storage tank to the tank truck or tank car, but if the tank is elevated sufficiently the milk may be released by gravity.

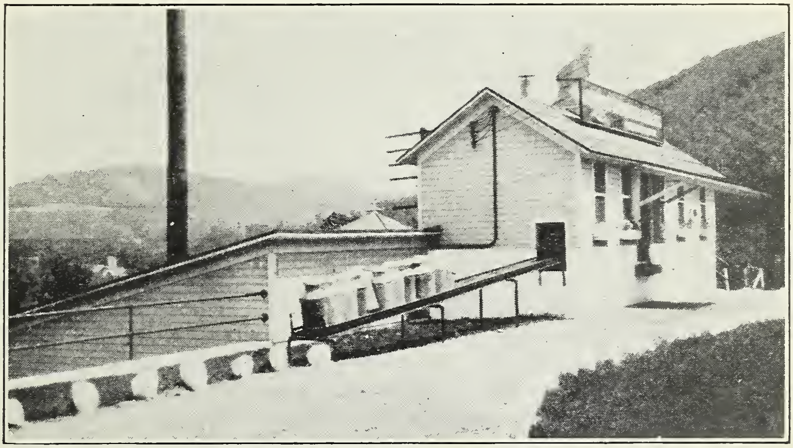

Figure 32.—A unique receiving station in which no milk pump is required. The milk flows by gravity from the weigh can and receiving vat to the milk cooler and can filler below and is shipped in cans by railroad.

To pump the milk from the receiving vat over or through the cooler in country receiving stations, the pumps used are of three types—piston, centrifugal, and rotary. Piston pumps are the most common. In the two plants (table 21) where no pump was used (fig. 32), one of which handled less than 10,000 and the other between 10,000 and 20,000 pounds daily, the cooler was located below the receiving vat, so that the milk flowed over it by gravity. In plants where internal tubular coolers were used, the piston pump was found in all except seven cases. Of these seven plants four used rotary pumps and three had centrifugal pumps.

The piston pumps may be operated by direct-connected motor, by belt power, or by steam. Operation by steam is most common, but consumes considerable steam, and cannot be depended upon for as uniform and constant flow of milk as operation by direct motor, and the latter method is becoming more popular where electric current is available. Only a few plants use belt-operated pumps, and this method also is not so dependable for uniform operation as use of the direct-connected motor.

Rotary and centrifugal pumps are usually operated by direct-connected motors, though belt power and steam turbine are sometimes used.

All three types of pumps were used to pump the milk from the cooler at the plants using pumps for this purpose. Where internal tubular coolers are used, the pump at the receiving vat will force the milk through the cooler to the milk-storage tank or direct to the tank truck or tank car, and only one pump is required. Usually only one milk pump is required at plants shipping in cans, as the cans are filled direct from the cooler.

The principal requirements for a milk pump are that it will pump a constant and uniform supply of milk without churning or causing foam, and that it can be easily cleaned.

MILK COOLERS

The surface cooler and the internal tubular cooler are both in common use in country receiving stations. A few plants use coil vats for cooling milk. With the internal tubular cooler, the milk is pumped through a series of pipes which are inclosed in pipes or jackets containing the cooling medium. This type of cooler is especially adapted to plants shipping the milk in tanks, as the milk can be pumped from the receiving vat directly through the cooler to the tank truck or car or to a milk-storage tank in the plant. Where internal tubular coolers are used at plants shipping in cans, a milk-storage tank must be used. The milk is drawn from this tank in filling the cans.

With the surface cooler (fig. 31), the milk passes over the tubes in a thin film and the cooling medium passes through the tubes. Where a surface cooler is used at plants shipping in cans, a storage tank is not required but its use has the advantage that the milk may be stored while it is being weighed, and the intake man can fill the cans later. Usually the cans are filled as fast as the milk is cooled, however, so that at least two men are required. While some of the surface coolers found in country receiving stations were covered, the majority were not.

The types of coolers and cooling mediums used at 163 plants are shown in table 22. Milk coolers may be installed in two sections, so that well or city water can be used in the first section, and brine, ice water, or direct-expansion ammonia in the last section. In 91 plants the milk was first precooled, with well water or city water, and in 3 plants the milk was cooled entirely with well water.

TABLE 22.—*Types of coolers and cooling media used at 163 country receiving stations*

Range of daily milk receipts (pounds)	Plants	Milk received daily per plant	Plants using—			Plants using cooling medium specified					
						Plants precooling with water			Plants without precooling		
			Surface cooler	Internal tubular cooler	Vat cooler	Ice water	Brine	Direct expansion	Ice water	Brine	Direct expansion
	No.	*Lb.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*
10,000 or less	45	7,374	39	5	1	5	7	10	[1] 11	4	8
10,001 to 20,000	55	15,629	44	10	1	6	10	14	13	6	6
20,001 to 50,000	53	32,313	33	[2] 16	4	4	19	11	9	9	1
Over 50,000	10	65,060	3	6	1	------	4	1	------	5	------
Total or average	163	21,807	119	37	7	15	40	36	33	24	15

[1] Includes 3 plants which used well water alone.

[2] Includes 1 plant using a special cooler.

While brine is the most common cooling medium used, direct-expansion coolers are used more than formerly. These coolers have been so improved that with proper control there is not much danger of milk being frozen on the pipes. They are relatively more economical to operate than brine coolers, as less refrigeration is lost if the ammonia goes directly to the cooler than if it goes through the secondary brine medium. This system is also simpler to operate than the brine system and less equipment is required. The brine system, however, is more elastic, as the brine can be stored for cooling after the refrigerating machine has been shut down or in case of a break-down. Also, with brine the refrigerating machine usually is of smaller capacity and operated for a longer time than with direct expansion (see Refrigeration)

REFRIGERATION

The capacity of the cooling equipment should be ample to handle the milk received in a short space of time, usually from 2 to 3 hours. Therefore, ample refrigerating facilities must be provided. Mechanical refrigeration, using either direct-expansion or brine, has many advantages, and is found in the majority of plants. In northern sections of the country where plenty of ice can be harvested in the winter and where the summers are comparatively short, ice is often used for cooling the milk.

The capacity of the mechanical refrigerating equipment and the number of hours that the compressor was operated at plants using both the direct-expansion system and the brine system are shown in table 23.

TABLE 23.—*Capacity of mechanical refrigerating equipment at country receiving stations of various sizes*

PLANTS USING DIRECT EXPANSION

Range of daily milk receipts (pounds)	Plants	Milk received daily per plant	Compressor				Size of motor [1]		
			Refrigerating capacity			Time operated daily—average	Average	Most common	Per ton capacity of compressor
			Average	Most common	Per 1,000 pounds of milk received daily				
	Number	*Pounds*	*Tons*	*Tons*	*Tons*	*Hours*	*Horsepower*	*Horsepower*	*Horsepower*
10,000 or less	18	7,811	7.1	5	1.0	3.1	14.5	10	2.02
10,001 to 20,000	19	15,500	11.2	12	.7	3.7	22.0	25	2.03
20,001 to 50,000	14	26,928	12.9	15	.5	4.2	27.5	30	2.20
Over 50,000	2	56,000	30.0	--------	.5	3.3	50.0	--------	1.65

PLANTS USING BRINE

Range of daily milk receipts (pounds)	Plants	Milk received daily per plant	Average	Most common	Per 1,000 pounds of milk received daily	Time operated daily—average	Average	Most common	Per ton capacity of compressor
10,000 or less	13	8,577	7.5	4	0.9	4.9	13.7	10	1.96
10,001 to 20,000	12	15,042	10.3	5 and 15	.7	7.0	19.6	25	2.01
20,001 to 50,000	17	37,471	18.3	15	.5	8.9	35.6	25	1.92
Over 50,000	11	72,182	22.4	30	.3	10.7	40.0	30	1.80

[1] To run compressor only. At 6 plants engines were used instead of motors.

As a rule, at plants using the direct-expansion system the machines are larger and are run fewer hours than those at the plants using the brine system. Where the direct-expansion system is used, the ammonia refrigerant passes directly through the coils of the milk cooler, and refrigeration cannot be stored for future use. Therefore the machine is run only while the milk is being cooled. With the brine system the machine may be run several hours longer, and the cold brine stored for use when needed. As a rule the motors used averaged approximately 2 horsepower per ton of capacity of the refrigerating machine.

Among the advantages of the direct-expansion system over the brine system are that less equipment, less floor space, and less power are required. Although a more expensive milk cooler is required, there is a reduction in total equipment and floor space because no brine-storage tank, brine pump, or piping are needed. No power is required for operating a brine pump. Furthermore, the power consumed per ton of refrigeration produced is less for the direct-expansion system than for the brine system, because a higher back pressure can be carried.[2]

The data in table 24 also indicate that in many plants the refrigerating machines used with the brine system were larger than necessary, and also that the cost of operation per unit of milk cooled was considerably greater than with the direct-expansion system.

The cost of electric power for operating the mechanical refrigerating machines at 66 plants of various sizes is shown in table 24. The cost per 1,000 pounds tended to decrease as the size of the plant increased. The variation from the average cost, however, was not great at any of the groups of plants except at the plants handling less than 10,000 pounds of milk daily.

TABLE 24.—*Cost of electric current used for operating mechanical refrigerating machines at country receiving stations*

Range of daily milk receipts (pounds)	Plants	Milk received daily per plant	Per month per plant	Per 1,000 pounds of milk received	
				Average	Variation
	Number	*Pounds*	*Dollars*	*Dollars*	*Dollars*
10,000 or less	12	7,475	43.41	0.22	0.13–0.44
10,001 to 20,000	24	15,077	68.21	.15	.09– .25
20,001 to 50,000	22	30,232	134.12	.15	.05– .21
Over 50,000	8	67,750	247.00	.12	.07– .16
Total or average	66	25,131	107.35	.16	.05– .4

The amounts and cost of ice (at an assumed price of $4 per ton) required at 44 plants using ice for cooling the milk are shown in table 25. The cost per 1,000 pounds of milk cooled did not vary much with the size of the plant.

TABLE 25.—*Ice used at country receiving stations*

Range of daily milk receipts (pounds)	Plants	Milk received daily per plant	Ice used			Average cost of ice used [1]		
			Per month per plant	Per 1,000 pounds of milk received daily		Per month per plant	Per 1,000 pounds of milk handled	
				Average	Variation		Average	Variation
	Number	*Pounds*	*Tons*	*Tons*	*Tons*	*Dollars*	*Dollars*	*Dollars*
10,000 or less	11	7,009	35.1	4.7	1.5–11.3	140.36	0.62	0.20–1.50
10,001 to 20,000	20	15,765	73.6	4.7	1.8– 8.3	294.60	.61	.24–1.10
Over 20,000	13	29,346	141.9	4.8	2.1– 9.0	567.61	.65	.30–1.20
Total or average	44	17,588	84.0	4.7	1.5–11.3	336.71	.63	.20–1.50

[1] At assumed value of $4.00 per ton.

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[2] BOWEN, J. T. REFRIGERATION IN THE HANDLING, PROCESSING, AND STORING OF MILK AND MILK PRODUCTS. U. S. Dept. Agr. Misc. Pub. 138: 20. 1932.

The estimated total operating cost of mechanical refrigeration at country receiving stations of various sizes is shown in table 26. The figures are based on the power cost plus a charge for interest on the investment in refrigerating equipment and for depreciation. Interest was figured at 5 percent per year on the investment and depreciation was figured at 10 percent. The costs for electric current used were the average costs obtained at the plants studied and for the sizes of plants indicated, as was shown in table 24. The approximate capacity of the refrigerating machines represents the sizes of machines most commonly found at plants handling these amounts of milk.

TABLE 26.—*Estimated cost of mechanical refrigeration at country receiving stations of various sizes*

Range of daily milk receipts (pounds)	Milk handled daily per plant	Approximate capacity of refrigerating machine	Approximate cost of machine and accessories	Daily charge for refrigerating equipment		Cost per 1,000 pounds of milk handled			
				Interest	Depreciation	Interest	Depreciation	Average cost of electric current	Total
	Pounds	*Tons of refrigeration*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
10,000 or less	7, 475	8	2, 500	0. 35	0. 69	0. 047	0. 092	0. 22	0. 359
10,001 to 20,000	15, 077	15	4, 000	. 55	1. 10	. 036	. 073	. 15	. 259
20,001 to 50,000	30, 232	20	4, 500	. 62	1. 23	. 021	. 041	. 15	. 212
Over 50,000	67, 750	30	6, 000	. 82	1. 64	. 012	. 024	. 12	. 156

The estimated total cost for refrigeration per 1,000 pounds of milk cooled ranged from 15.6 cents at the largest plants to 35.9 cents at the smallest plants. If these estimated costs are compared with the costs when ice valued at $4 per ton was used (table 25) it will be observed that on an average the cost where ice is used is nearly double the cost where mechanical refrigeration is used for similar quantities of milk. Of course, if ice can be procured at a lower cost per ton, the difference would not be so great.

WELL PUMP

Most country stations have their own wells (p. 5). An efficient well pump is therefore necessary. Where electric current is available it is the most dependable power for driving the pump. Many plants use a windmill, but it is desirable that this power be supplemented by an electric motor if possible. Many plants have deep driven wells, and there are available many motor or steam-driven pumps for deep wells.

CAN WASHERS

Can washing is an important operation in country receiving stations. Unless the producers' cans are thoroughly cleaned and treated to kill bacteria with steam or by chemical treatment, milk of low quality will be received. Two types of can washers are in common use, the rotary and the straightaway power-driven machines (table 21). These machines wash the cans with a strong alkali solution, rinse, and steam them. When the cans come from the machine they should be dry within a few seconds. This is accomplished either by the heat from the steam or by a final blast of hot air. These can washers are usually operated by direct-connected motors. The rotary type is more commonly used in country plants than the straightaway type, the latter being found principally at the larger plants. With the rotary-type washer one man puts the cans into the machine and takes them out after they have passed through the machine and passes them out of the door to the producer's truck or to a conveyor leading thereto. At large plants where the straightaway type of washer is used, the man who dumps the milk may put the cans directly into the machine. After the cans pass through the machine, the covers usually are replaced on the cans automatically, and the cans are automatically placed on a conveyor leading to the producer's truck. Thus, with a conveniently arranged weigh can one man can dump and weigh the milk and operate the can washer.

At a considerable number of plants automatic can washers were not used. At some of these plants the cans were washed by hand in a vat or sink and then rinsed and steamed. At others the cans were sent through a small machine which contained a waterspout for rinsing them, steam jets, and a suction drier. At 14 plants no can washers were used and the cans were rinsed only.

At most plants shipping in cans there were two can washers, one being used for washing the producers' cans and one for the shipping cans. Some small plants were so arranged that only one can washer was required.

BOILERS

Boilers are required in country receiving stations to produce steam and hot water for cleaning the cans and milk-handling equipment; to produce steam for steam-driven pumps and for engines when they are used. The types of boilers used at 146 plants are shown in table 27.

TABLE 27.—*Types and sizes of boilers used at 146 plants*

Range of daily milk receipts (pounds)	Plants	Milk received daily per plant	Plants using indicated type of boiler			
			Upright or vertical	Economic	Scotch marine	Horizontal return tubular
	Number	*Pounds*	*Number*	*Number*	*Number*	*Number*
10,000 or less	34	7,019	21	8	3	2
10,001 to 20,000	47	15,784	15	16	2	14
20,000 to 50,000	53	30,973	3	16	5	29
Over 50,000	12	74,250			1	11
Total	146		39	40	11	56

Range of daily milk receipts (pounds)	Plants	Milk received daily per plant	Rated horsepower of boiler				
			Per plant		Per 1,000 pounds milk received daily	Variation	
			Average	Most common		Per plant	Per 1,000 pounds milk received daily
	Number	*Pounds*	*Horse-power*	*Horse-power*	*Horse-power*	*Horse-power*	*Horse-power*
10,000 or less	34	7,019	26.2	30	3.8	6- 85	0.8-10.6
10,001 to 20,000	47	15,784	44.7	40-50	2.9	6-125	.3- 7.1
20,001 to 50,000	53	30,973	71.4	60	2.3	20-150	.9- 5.0
Over 50,000	12	74,250	123.8	100	1.6	50-300	.7- 3.0
Total	146						

Upright or vertical boilers were most commonly used at the small plants. These can be obtained in very small sizes. They require very little floor space and no brickwork. Steam can be developed comparatively quickly with these boilers.

The Economic and horizontal return tubular boilers were more commonly used at the medium-sized and large plants. Scotch marine boilers were used at 11 plants. These boilers are entirely self-contained and do not require any brickwork. The Economic boiler is very popular in small and medium sized plants. This is also a self-contained boiler and requires very little brickwork. It requires a comparatively small floor space and is not built in as large sizes as the horizontal return tubular boiler. The latter type was used principally at the larger plants. It can be obtained in sizes up to 150 horsepower. Some large plants, especially those where byproducts are manufactured, install two boilers so that one can be thoroughly cleaned or overhauled without shutting down the plant.

The sizes of boilers used at 146 plants of various sizes are also shown in table 27. The boiler horsepower used per 1,000 pounds of milk received daily decreased as the size of the plant increased.

LISTS OF EQUIPMENT

The following lists of equipment with the approximate costs are suggested for country milk-receiving stations of different capacities. These lists may not cover all requirements, but are given as a guide to aid those who wish to establish plants. The figures on cost are only approximate, as these will depend on local and changing conditions.

EQUIPMENT FOR PLANT TO RECEIVE 500 GALLONS DAILY

The principal equipment required for a plant to receive and cool approximately 500 gallons, or up to 5,000 pounds, of milk daily, the milk to be shipped in cans (see floor plan, fig. 24) is as follows:

One five-beam platform scales.
One weigh can (capacity 600 pounds).
One 150-gallon receiving vat, with cover.
One milk pump (capacity 3,000 pounds per hour).
One tubular milk cooler (capacity 2,500 to 3,000 pounds per hour).
One rotary can washer, with motor (capacity 100 cans per hour).
One no-foam can filler.
One 10-horsepower boiler with accessories.
One 3- to 5-ton refrigerating machine, with motor.
One brine tank with piping and fittings.
One brine pump.
One well pump, if necessary.
Conveyor for producers' cans.
Conveyor for shipping cans.
One sink.
One 24-bottle Babcock tester.
Necessary steam and water pipes and fittings.

Approximate total cost, from $4,000 to $5,000.

If the plant is not so arranged that both producers' and shipping cans can be washed in the same room, another can washer would be required.

For a plant of the same capacity to ship the milk by tank truck (see floor plan, fig. 25) the following changes in equipment would be made: A less expensive can washer could be used. No can filler or conveyor for filled cans would be required. An internal tubular cooler could be used instead of a surface cooler. In case the tank truck cannot be depended on to always be on hand when the milk is being cooled, an insulated milk-storage tank would be required. If a surface cooler is used, a milk pump would be required to pump the milk from it to the milk-storage tank or to the tank truck.

EQUIPMENT FOR PLANT TO RECEIVE 1,000 TO 1,500 GALLONS DAILY, THE MILK TO BE SHIPPED BY TANK TRUCK

The principal equipment required for a plant to receive and cool 1,000 to 1,500 gallons, or about 10,000 to 12,000 pounds, of milk daily, the milk to be shipped by tank truck, is as follows:

One automatic-dial scales.
One two-compartment weigh can (capacity 800 pounds).
One receiving vat with cover (capacity 200 gallons).
One milk pump (capacity 6,000 pounds per hour).
One milk cooler, surface or internal tubular (capacity 6,000 pounds per hour).
One motor-driven can washer with steamer and drier.
One 30-horsepower boiler with accessories.
One 10-ton refrigerating machine with accessories and 20-horsepower motor.
One brine tank and brine pump.
One 1,500-gallon insulated milk-storage tank.
One well pump, if necessary.
One sink.
One 24-bottle Babcock tester.
Necessary steam and water pipes and fittings.

Approximate total cost, from $8,000 to $9,000.

If the milk is to be cooled by use of a direct-expansion cooler, a brine tank and brine pump would not be required.

The arrangement of such a plant may be similar to that illustrated in figure 27, except that no ice house would be required.

EQUIPMENT FOR PLANT TO RECEIVE 1,500 TO 2,000 GALLONS DAILY, THE MILK TO BE SHIPPED IN CANS

The principal equipment required for a plant to receive and cool 1,500 to 2,000 gallons, or approximately 15,000 pounds, of milk daily, the milk to be shipped in cans, is as follows:

One automatic-dial scales (suspended type).
One two-compartment weigh can (capacity 1,000 pounds).
One receiving vat with cover (capacity 300 gallons).
One milk pump (capacity 8,000 pounds per hour).
One tubular milk cooler (capacity 8,000 pounds per hour).
Two motor-driven can washers, with steamer and drier.
One 40-horsepower steam boiler with accessories.
One 15-ton refrigerating machine with accessories and 30-horsepower motor.
One brine tank and brine pump, with piping and fittings.
One no-foam can filler.
One well pump, if necessary.
One sink.
One 24-bottle Babcock tester.
Necessary steam and water pipes and fittings.

Approximate total cost, from $8,000 to $10,000.

If the milk is to be cooled by a direct-expansion cooler, the brine tank and brine pump will not be required.

The arrangement of the equipment would be similar to that shown in figure 26.

EQUIPMENT REQUIRED FOR PLANT TO RECEIVE 3,000 GALLONS OF MILK DAILY, THE MILK TO BE SHIPPED IN TANKS

The principal equipment required for a plant to receive and cool approximately 3,000 gallons, or about 25,000 pounds, of milk daily, from which the milk is to be shipped by tank car or tank trucks, is as follows:

One automatic-dial scales (suspended type).
One two-compartment weigh can (capacity 1,000 pounds).
One receiving vat with cover (capacity 400 gallons).
One milk pump (capacity 12,000 pounds per hour).
One milk cooler, surface or internal tubular (capacity 12,000 pounds per hour).
One motor-driven can washer, either straightaway or rotary, with steamer or drier, for washing producers' cans.
One 50-horsepower boiler with accessories.
One 20-ton compressor, with accessories and 40-horsepower motor.
One brine tank and brine pump.
One 3,000-gallon insulated milk-storage tank.
One well pump, if necessary.
One sink.
One 36-bottle Babcock tester, sample bottles, etc.
Necessary steam and water piping and fittings.

Approximate total cost, from $12,000 to $14,000.

If the milk is to be cooled by a direct-expansion cooler, a brine tank and brine pump would not be required.

The arrangement of the equipment would be similar to that shown in figure 27 or 29

UTENSILS AND SUPPLIES

In addition to the equipment listed, the following utensils and supplies would be necessary:

Pipe and monkey wrenches.
Boiler-firing equipment.
Compressor and machine oil.
Ammonia.
Calcium chloride.
Washing powder.
Packing, cotton waste, belt lacing, etc.
Sample and test bottles.
Sampling tube or dipper.
Dairy thermometers.
Pipettes.
Combined acid bottle and pipette.
Lactometer.
Sulphuric acid.
Milk sheets.
Soldering outfit and set of tools.

COMMON ACCOUNTING FORMS USED AT COUNTRY RECEIVING STATIONS

The following forms are suggested for keeping essential records at country receiving stations.

Form A is to be used in the receiving room for recording the daily milk receipts. This milk sheet is shown for a 15-day period, but may be modified for a shorter or longer period if desired. The sheet may be fastened to the wall of the receiving room or to a desk so that it is convenient for the man who receives the milk to record the weights. It is desirable that the patrons' names be entered by routes in the approximate order of their arrival at the station.

If the payments to producers are made by check from the city plant, the total receipts shown on the milk sheet may be entered on Form B at the end of the period. This form is then sent to the main office.

On Form C may be kept the records of each patron for the period. This record may be obtained from Form B at the main office or in case the checks are made out at the receiving station the receipts may be entered by the station operator directly from the milk sheet (Form A).

On Form D may be recorded the receipts for each patron for the period, the net amount due, and the amount and number of the check when payment is made.

Form E may be used by the station operator to report the quantity shipped each day to the city plant, together with information regarding cans, etc.

On Form F may be recorded the daily receipts from country stations at the city plant. Each form would contain a record of the receipts for 1 month for each station.

On Form G the station operator may keep a daily record of all milk, etc., received and the disposal of the same. The quantity not accounted for would be the shrinkage for that day.

Form H may be used to record the station expense each month and cost of operation per hundredweight received.

Form A.—Record Of Daily Milk Receipts

For 15-day period from ______________ 19 __ to ______________ 19 __

Patron		Milk received on day no.—															Total receipts, 15 days	Average butter-fat content
No.	Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15		
		Lb.	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Pct.*
	Total																	

Form B.—Receiving Report

Station ______________________________ Date ________________ 19 __

Operator ______________________________

Milk received in 15-day period from______________ 19 __ to ______________ 19 __

Patron		Grade of milk	Total receipts	Average butterfat test	Price per 100 pounds	Amount	Deductions		Net amount due patrons
No.	Name						Hauling		
			Pounds	*Percent*	$	$	$	$	$

Form C.—Monthly Record of Milk Receipts From Individual Patrons

Route--------

Patron's no--------

Month---------------19--

Patron's name-------------------------

Grade------

Price------

Date	Pounds	Gallons	Percentage of butterfat			
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
30						
31						
Total						

Total milk received, pounds--------

Average butterfat, percent--------

Price per 100 pounds------$-------

Gross amount due producer--$-------

Less deduction for hauling----$-------

Net amount due producer----$-------

FORM D.—PATRONS' SETTLEMENT SHEET

Date________________19__

Station____________

For period from____________19__ to ______________19__

Patron		Milk		Cream		Gross value	Deductions		Net amount	Amount of check	Check no.
No.	Name	Weight	Value	Weight	Value		Hauling				
		Pounds	$	*Pounds*	$	$	$	$	$	$	

FORM E.—STATION SHIPPING REPORT

From____________________Station Date________________19__

To____________________Dairy Company

We ship you this day:

Product	Cans	Gallons	Pounds	Percentage of butterfat
Milk				
Cream				
Skim milk				

Number of empty cans received____________.

Number of empty cans on hand____________.

Number of empty cans needed tonight_____________.

Remarks____

____

____

________________________Station operator.

Form F.—Monthly Record of Milk Receipts from Station

Station ________________________ Month ________________ 19__

Date	Milk			Butterfat content		
	Cans	Gallons	Pounds	Percent	Pounds	
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
30						
31						
Total						

Form G.—Daily Balance of Stock

Station ________________________

Operator ________________________ Date ________________ 19__

	Today's receipts				Disbursements					
	Milk	Cream	Skim milk		Milk		Cream		Skim milk	
	Lb.	*Lb.*	*Lb.*		*Gal.*	*Lb.*	*Gal.*	*Lb.*	*Gal.*	*Lb.*
On hand last night				Shipped to						
Received from producers.				Shipped to						
Other receipts				Sales to patrons						
Transferred				Local sales						
				To employees						
Total to account for				Known losses						
Total accounted for				On hand tonight						
Shrinkage				Total accounted for						

FORM H.—MONTHLY OPERATING EXPENSE

Station ________________________ Month ending ________________ 19__

Operator ______________________ Total pounds of milk received ________

LABOR AND SUPERVISION

Number of men	Department	Wages	Amount of pay roll	Cost per 100 pounds
		$	$	$
Total				

SUPPLIES

	Quantity	Value	
Coal		$	
Ammonia and oil			
Power and light			
Washing powders			
Ice			
Miscellaneous			
Total			

OVERHEAD

	Department	Cost for month	
Office salaries		$	
Rent			
Repairs			
Insurance and taxes			
Telephone			
Miscellaneous			
Total overhead			
Total expense			

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